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and
The Foundry Trades' Equipment and Supplies Association

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Technical College Buildings

Several deputations have gone from this country in recent years to see technical college buildings abroad in order that our own developments should be of the most modern description. In 1930 a deputation went from the Manchester Education Committee, and this year one from the Birmingham Education Committee visited Holland, Belgium, France, Switzerland, Austria and Germany, according to a report just issued. We are not particularly concerned with buildings, but some comments made in this report on attitudes adopted abroad to technical education are worthy of consideration. It can be said to begin with that if these countries were lukewarm in their attitude they would have ample excuse on account of the very great financial difficulties with which they have been beset. What do we find? The Birmingham deputation was profoundly impressed with the amazing scale on which provision is made for technical instruction of all grades. The size, dignity and spaciousness of the buildings are scarcely paralleled anywhere in this country and the provision of apparatus and equipment is much superior to that in the majority of our institutions. Nothing, it is reported, but the best and most recent was considered good enough. The report also says that this intense belief in technical education was held by industry as well as the State. Examples are given of munificent support from industry. In Switzerland and Austria there are compulsory day-training schemes for all apprentices, of three or four years' duration. Members of industrial staffs are allowed to teach in the day time in technical institutions. A striking feature is the great stress laid on full-time training before entering industry and the almost complete absence of organised evening classes of high standard. The training usually follows on either the elementary or the secondary school, and ranges from trade courses to advanced professional courses. It is believed on the Continent that the technical education required of those in responsible industrial posts can no longer be reached by part-time study, day or evening.

Are industrialists in this country so deeply wedded to the individualist tradition that they cannot believe that any good comes out of collective activity, even of the State? If they are found exercising any interest in or influence on education it is usually as elected representatives, looking politically rather than industrially at the problem. There are signs of change and improvement, but it seems true that employers as a whole do not *believe* in technical or trade education, and this results in the curious paradox that those employees who take courses available are training themselves not for the grade they are in but for the purpose of getting out of it.

Employment and the Foundry Industry

An exceedingly well-informed article appears in the current issue of the "F.B.I. Business Barometer," entitled "The Trend of Employment." This is of more interest to the foundry industry than to other trades, because castings form an important raw material for so many types of manufacture. This article, after pointing out that of the two million unemployed not more than 370,000 of the men at present out of work have been unemployed for 12 months continuously, comments that this figure is distinctly higher than in pre-war days, and attributes this state of affairs to a serious decline in the export of British goods, to the change over from an emigrating to immigrating state, and (temporarily) to the increased use of machinery. Two tables are included, the first of which sets out the amount of contraction experienced by certain industries since 1923, whilst the second details the expansion in others. Happily the second shows an increase of nearly two million operatives, whilst the former a decrease of the order of one and a quarter million. In statistics of this character the growth of population is of paramount importance. Amongst those which should have suffered a decline in business are foundries making castings for coal mining, the iron and steel trades, the tinplate industry, marine, textile and general engineering, the shoe trade and the railways, whilst increases should have been registered by concerns catering for both the light and heavy electrical industries, the automobile and aircraft trades, hosiery, printing, silk and artificial silk, builders' merchants, laundries, and road transport in general. Curiously enough, in neither table is the chemical industry mentioned. With few exceptions there are not very many foundries which cater for both the contracting and expanding industries, the one great exception being textile-machinery making, which covers both

(*Concluded on page* 96.)

XUM

American Society for Testing Materials

ANNUAL MEETING

Over 1,000 members were present at the 1935 annual meeting in Detroit. The work of A.S.T.M. committees continued intensively—there were about 150 committee meetings during the week.

At the 15 formal meeting sessions about 100 technical papers and reports were presented on a wide range of subjects. As a result of the meeting, some 39 new proposed specifications are to be published as tentative, about 22 existing tentative standards will be balloted upon for adoption as official standards and over 85 standards and tentative standards will be tentatively revised. Previously existing revisions in some 16 standards are to be adopted as standards.

In addition to actions taken at the meeting on standards, a number of the committees finished work on other new specifications which will be submitted to a letter ballot of the entire committee memberships and submitted to the Society during the summer to be published as tentative. A large number of new projects are to be undertaken by various groups indicating increasing interest in the work in the material fields.

Spectrographic Analysis

One session of the meeting was devoted to spectrographic analysis, the programme being sponsored by the A.S.T.M. Committee E-2, of which Mr. H. V. Churchill is chairman, and Mr. C. C. Nitchie secretary. The symposium had two objects in view, one to give those working in this field definite information as to the methods used by those depending upon spectrographic analysis for the control of quality in a variety of industries; the other to indicate to those not actually engaged in spectrographic work, but interested in the possibility of securing more rapid and reliable methods of testing, the fact that numerous laboratories have found in the spectrograph an invaluable tool that will shorten the time required for analysis and give more complete and definite information as to the composition of materials than can be obtained in any other way. The papers covered work on steel samples, use in the platinum industry, quantitative analysis of magnesium alloys, impurities in cadmium, electrodes for spectrochemical use and quantitative analysis of non-ferrous alloys. Consideration is being given to the possibility of reprinting these Papers during the summer in a special pamphlet.

Marburg Lecture

Dr. L. B. Tuckerman, National Bureau of Standards, Washington, in delivering the tenth Edgar Marburg Lecture on "Aircraft: Materials and Testing," described the relation between the mechanical properties of the material and the design of struts, beams, etc., and the craft as a whole, to produce light-weight construction. He stated that theoretical and experimental investigation all show that light-weight construction depends on spreading the material as far as possible out from the axis of the elements. hence there is the thin-walled construction, that is, thin webs and flanges, thin-walled tubes, etc. The significant properties, density, strength—density ratio and modulus density-ratio of selected materials were compared. The comparison shows, that from these purely structural considerations, with the materials now available, there is little choice between the three types of construction now in use, wood, light aluminium alloys and high-strength alloy steels. The choice between them must be based on other considerations, ease of fabrication, resistance to deterioration by weathering, etc., and finally upon knowledge of the designs which will utilize best the possibilities of the material.

He indicated that no radical improvement in light-weight construction is at present to be expected from still further increasing the strength of the materials. There is, however, much room for improvement in the knowledge of the possibility of designing to utilise more fully the strength of materials now available. Systematic tests such as these offer present promise of materially improved light-weight construction. Tests of this kind are being carried out in many laboratories, but many more are needed if progress in light-weight construction is to be maintained.

Relationship of Specifications to the Engineering Profession

At the opening session of the meeting Mr. C. F. Hirshfeld, chief of the research department, the Detroit Edison Company, discussed the "Relationship of Specifications to the Engineering Profession." He indicated that the development of engineering has rested solidly upon the acquisition of knowledge regarding materials.

In all cases a material is used because of certain properties or characteristics; in some cases in spite of some of them. In either event a knowledge of properties and characteristics is essential to success. The practice of engineering is based upon the choice and use of just those materials adapted to produce the desired technical and economic results. He stated that the engineer must realise always that each item of a technical specification dealing with materials was of value only as it affected the usefulness of the material for a specific purpose. And there lay much of their trouble.

In indicating the manner in which engineering, materials and specifications developed, Mr. Hirshfeld expressed his belief that behind it all lay research, and that in general they progressed in proportion to the extent of the research: "Specifications are tied to engineering both as to development and practice. They are indeed inseparable. We progress only because we maintain a balance between the development of knowledge of properties of materials, their application to engineering purposes and the production of usable specifications." After stating that there was still a too general lack of appreciation of the real significance of what they called a specification, and that engineering could only be as good as its specifications, he pointed out that their great weakness at present lay in their lack of a more orderly procedure for uncovering the fundamental knowledge required.

Non-Ferrous Metals

The session of the A.S.T.M. meeting devoted to non-ferrous metals and metallography was marked by several outstanding committee reports. Committee B-6 on Die-Cast Metals and Alloys not only had an interesting report but also had one of the most impressive displays in the Exhibit. The committee had prepared new specifications for lead- and tin-base alloy die-castings which will be issued as a tentative standard. Five typical alloys were specified, designated as grade Nos. 1 to 5 in order of decreasing tin content.

The Committee on Metallography, E-4, had prepared an extensive revision of the standard methods of metallographic testing of iron and steel (E3—24) and the standard methods of metallographic testing of non-ferrous metals and alloys (E5—27). These two standards had been combined into a *proposed* recommended practice for metallographic testing of ferrous and non-ferrous metals

Presentation to Mr. T. R. Walker

A service of Old Sheffield plate, so rare that it can be regarded as a museum piece, has been presented by the Sheffield Convention Committee to Mr. T. R. Walker, B.A., the Committee's honorary secretary. It is a tea service of genuine old Sheffield plate. Whilst individual pieces are by no means rare, a complete service in such a perfect state of preservation is unique. Such a presentation constitutes a really appropriate recognition of Mr. Walker's successful accomplishment.

TEA SERVICE OF OLD SHEFFIELD PLATE PRESENTED TO MR. T. R. WALKER.

Employment and the Foundry Industry

(*Concluded from page* 95.)

cotton and artificial silk, and, to a lesser extent, the roll founders. We do not, however, advise foundry owners radically to depart from their existing specialities, as we have noticed that to introduce themselves the first thing they do is to cut prices. Rather would we advise that the contracting sections of the industry should co-operate so as to maintain a reasonable margin of profit. It is interesting to note that by 1941—a matter of six years—the unemployment problem will be well on the way to solution on account of population shrinkage. Another factor stressed in the report is that the newer and expanding industries must do their utmost to assume that pride of place previously held by several of the contracting trades in the international export markets. A final factor worth noting is that if some grandiose scheme of public relief works were to be started the numbers of unemployed, who both could and would work on it, would be surprisingly small!

German Progress in Piston Rings, Brake Drums and other Automobile Castings*

By W. A. GEISLER (Alfred Teves, Maschinen und Armaturenfabrik, G.m.b.H., Frankfurt-am-Main)

[GERMAN EXCHANGE PAPER]

Piston rings for motor cars were originally made from sand cast grey iron bushes, but as requirements in respect of quality became more exacting, research was directed to finding better materials and superior foundry processes. With the object of obtaining a fine-grained, wear-resisting piston ring, the single-ring casting process as in American practice was introduced in Germany several years ago, and it is now an established fact that the single-ring has been almost universally adopted in Germany. Piston rings made by the single-casting process have only very small machining allowance, and the rings can be machined more economically than those made as bushes. This was not, however, the determining factor: much more important and decisive was the material improvement in quality as compared with those machined from cylinders[1].

Single-Cast Rings

Standard single-cast rings are not alloyed, and thus they satisfy in every respect the requirements for water-cooled motor-car engines. The steady increase in the efficiency of the engines and the continued development of the Diesel type and of air-cooled engines in general are, however, associated with a considerably higher loading of the piston ring, and every increase in efficiency means a further loading. Here the standard single ring reaches the limit of its capacity: the "efficiency reserve" is exhausted.

How can a ring with a higher efficiency reserve be obtained? The simplest and safest way is by the addition of certain elements as alloys to the piston-ring material. Attempts have been made to impart a higher efficiency reserve to the rings by heat-treatment or by hardening, but it has been found that for a successful heat-treatment the ring has to be alloyed.

The alloying of single-cast rings is, however, beset with difficulties. For, in order to obtain a casting fit for machining, it is necessary that single rings, with their small sections of only a few square millimetres and high percentage of carbon, should contain 2.7-3.0 per cent. silicon. This, however, represents practically the softest cast alloy, as cast iron having a Si-content of over 3 per cent tends to harden again. Thus, if it be desired to improve the piston-ring material by alloying—and in this case, as explained further on, only carbide-forming or carbide-containing elements are suitable—the rings are liable to become so hard, that they cannot be machined. According to the writer's observations, the addition of special elements as alloys is possible only to a limited extent in the case of single rings. Personal experience and tests have shown that the centrifugal casting process is much more advantageous in the case of alloyed piston rings. Here the rings are cast in the shape of a bush, from which the rings are obtained by machining. Although the centrifugally cast bush is made in a chill mould, the considerably larger mass of the bush—*i.e.* the lower cooling speed—naturally permits harder alloying, and therefore the addition of carbide-forming special elements no longer presents any difficulty.

MR. W. A. GEISLER.

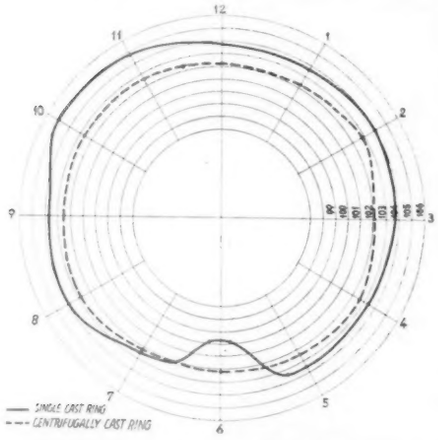

FIG. 1.—ROCKWELL (SCALE B) HARDNESS VARIATIONS AT PERIPHERY OF PISTON RINGS.

Centrifugally-Cast Rings

Another not to be underrated advantage of the centrifugally cast ring is the uniformity of the material throughout the entire section (see Fig. 1). For the single ring, at least one gate is required; if the sections be small a riser is also necessary. At these points, however, the ring will remain liquid for a longer period and cool more slowly, so that it acquires a different structure and becomes softer. Rings which are out of truth and a rapid fall in pressure may be the result.

The writer holds the view that standard piston rings which are not subjected to excessive stresses can be produced most advantageously by the single-ring process. The many millions of single rings produced during the last few years in Germany, as also in America, are the best proof of this. For alloyed piston-rings subjected to high stresses, *i.e.*, rings having a higher efficiency reserve, such as those for use in Diesel engines and aero-engines, the centrifugal casting process appears to be better suited.

Addition of Special Elements

The special elements to be regarded as alloy constituents are those which are not usually contained in grey cast iron, *e.g.*, nickel chromium, molybdenum and vanadium. These elements are added to improve the mileage, to ensure greater tensile strength and, especially, to increase the heat resistance of the casting. With normal alloys, the carbon content of single-cast rings is kept fairly high, *i.e.*, about 3.6-3.8 per cent., so as to obtain a medium-coarse graphite formation, as this, according to recent experience and confirmatory tests, ensures the highest resistance to wear [2 4 5]. Eutectic graphite generally contains patches of ferrite, which prove highly detrimental to the durability of the casting. The formation of eutectic graphite must therefore be avoided.

As the result of numerous experiments the fact was confirmed; that the mileage of a piston ring is improved by a well-marked phosphide network [6 7 8 9]. But as phosphorus reduces the tensile sterength of the casting, limits are set to its use as an alloy. The manganese content is kept at the highest limit, from 0.8-1.0 per cent. on an average.

It would be beyond the scope of this Paper if the machine-finish of the piston rings was discussed. It is worthy of note, however, that as far back as 1918, J. E. Hurst [10] found that the usual machining condition of cast-iron castings has a decisive influence on their wear-resisting qualities, the wear generally being all the less, the finer the finish machining condition. The correctness of this view was confirmed in Germany by Th. Klingenstein [11]. As a result, the demand for ground piston rings is continually increasing.

Reverting to the question of material, it was formerly held that in order to render a piston ring resistant to wear it was only necessary to provide for an essentially pearlitic structure." Experience, however, has shown that pearlite alone is not the determining factor. The advantage of a phosphide network has already been mentioned. Moreover, a fine-grained and, above all, *resistant* structure has proved to be necessary. For piston rings in internal-combustion engines are now subjected to temperatures which are often very considerable, with the result that the tension of the rings is seriously affected if the structure is not resistant.

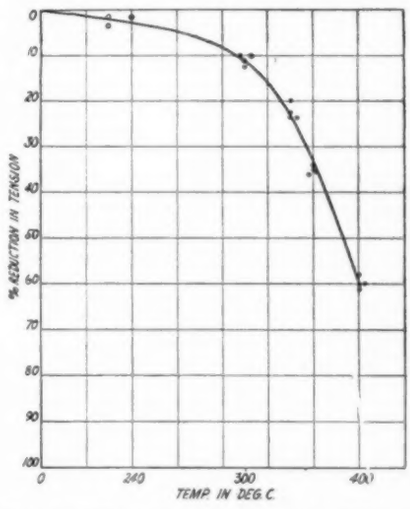

FIG. 2.—PERCENTAGE REDUCTION IN TENSION IN RELATION TO TEMPERATURE.

Tests at Elevated Temperatures

The examination of a single ring (Fig. 2) showed that at each heating of 24 hrs. duration

* A Paper read before the Annual Meeting of the Institute of British Foundrymen at Sheffield.

and at increasing temperature, a constantly increasing fall in tension occurred. Up to 300 deg. C. there was a tension drop of about 10 per cent., which may still be regarded as quite tolerable. Above 300 deg. C., however, the pressure falls rapidly, the loss at 400 deg. C. being already about 60 per cent.! When the pressure is greatly reduced, however, a piston ring no longer fulfils its allotted function, *i.e.*, to maintain tightness. The rings either permit the passage of oil or allow the hot gases to sweep past them, so that the oil film is destroyed and the rings wear out rapidly or seize.

The resistance of piston rings to heat—and here, according to recent measurements, temperatures of 250 to 350 deg. C. and sometimes even higher are encountered—depends on the resistance of the carbides contained in the cast iron, as also on their size and arrangement. Pearlite consists of a lamellar arrangement of iron-carbide (cementite, Fe_3C) and ferrite.

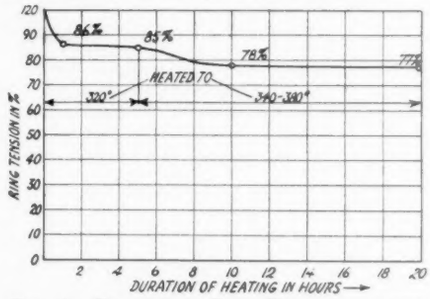

FIG. 3.—PERCENTAGE RING TENSION RELATED TO DURATION OF HEATING.

Effect of Special Elements

The formation of the pearlite is also of importance; coarsely lamellar pearlite (bush casting) is much less resistant than finely-lamellar pearlite or sorbite, such as is met with in extremely fine-grained cast iron (single or centrifugal casting). The resistance of the carbides to heat can be materially improved by the addition of carbide-forming or carbide-promoting elements. These include chromium, molybdenum, vanadium, tungsten, arsenic, antimony and bismuth.[13] In personal experiments, chromium, vanadium and, particularly, molybdenum have so far given the best results. Experiments with tungsten are still proceeding.

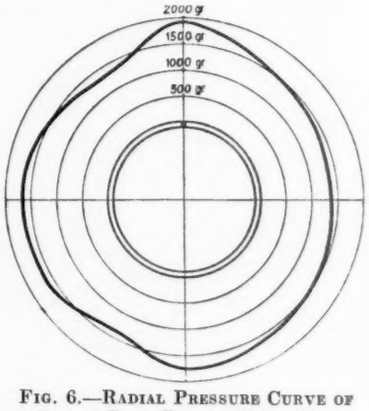

FIG. 6.—RADIAL PRESSURE CURVE OF SINGLE-CAST PISTON RING HEAT-TREATED.

Chromium is the most effective of the carbide-forming and carbide-promoting elements. Even the addition of only a few tenths per cent. of chromium causes a substantial increase in the heat-resistance, whilst at the same time producing a higher degree of hardness and tensile strength. The action of chromium is so sharp, however, that it can only be added, alone, in very small quantities. In most cases chromium is added in combination with nickel, which has the opposite, *i.e.*, a graphite forming, effect. Additions of molybdenum gave very good results, as this element has not the potency of chromium, but yet promotes in a remarkable degree heat-resistance and tensile strength.[13 14] According to the writer's observations, in numerous experiments, nickel additions alone, even with the reduction of the silicon content, yielded no advantages whatsoever, either as regards the mileage or the heat-resistance of piston-ring material. For the same reason, other graphite-forming elements, such as titanium, copper and aluminium, proved equally unsatisfactory. Cobalt had a neutral action, within the limits in which it was added to the cast iron.[13 14]

In order to determine their heat-resisting properties, the finished piston rings are placed in a cylinder of suitable diameter and heated for a given period, generally 24 hrs., at 200, 300 or 400 deg. C. The loss in tension in percentage of the initial tension may be regarded as the measure of the heat-resistance. It is interesting to observe that a piston ring heated at a certain temperature (*e.g.*, 320 deg. C.) suffers a fall in pressure after only a short period, but then maintains a constant effect, that is to say, that the piston ring, once it has suffered the tension drop corresponding to the temperature, retains its tension in relation to these temperatures, *i.e.*, it remains resistant to heat. When heated at higher temperatures (*e.g.*, 340 to 380 deg. C.), a further fall in tension then occurs, which again follows a nearly straight line, as is shown in Fig. 3.[2] The dependence of the heat-resistance upon various alloy constituents is shown in Fig. 4, the high value of the chromium and molybdenum alloys being immediately obvious.

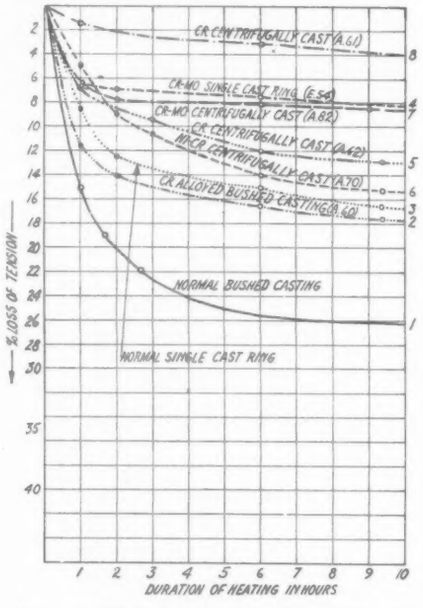
% LOSS OF TENSION
DURATION OF HEATING IN HOURS
CR. CENTRIFUGALLY CAST (A.61)
CR-MO. SINGLE CAST RING (E.54)
CR-MO. CENTRIFUGALLY CAST (A.62)
CR. CENTRIFUGALLY CAST (A.62)
MICRO CENTRIFUGALLY CAST (A.70)
CR. ALLOYED BUSHED CASTING (A.60)
NORMAL BUSHED CASTING
NORMAL SINGLE CAST RING

FIG. 4.—HEAT-RESISTING PROPERTIES OF PISTON-RING MATERIALS RELATED TO THE LOSS OF TENSION.

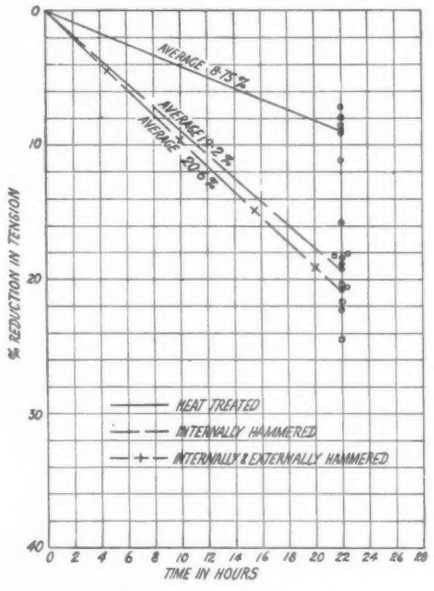

FIG. 5.—REDUCTION IN TENSION OF HEAT-TREATED AND HAMMERED PISTON RINGS AFTER 22 HOURS' HEATING AT 300 DEG. C.

The test temperature was the same for all rings, namely, 340 deg. C. Similarly, all test rings had the same dimensions.

Tension Losses in Piston Ring Types

Curve 1 shows the fall in tension in a standard bush-cast ring. On the addition of chromium the heat resistance was found to be materially improved (Curve 2). Curve 3 indicates the tendency of the tension in a standard unalloyed single-cast ring. The addition of molybdenum (Curve 4) brought about a quite considerable increase in the heat resistance.

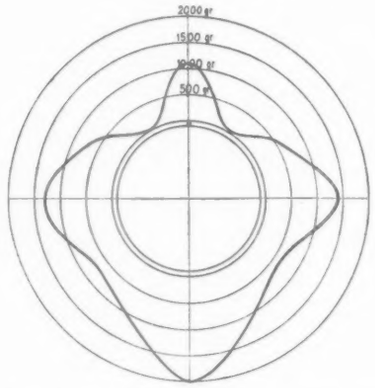

FIG. 7.—RADIAL PRESSURE CURVE OF SINGLE-CAST PISTON-RING—HAMMERED.

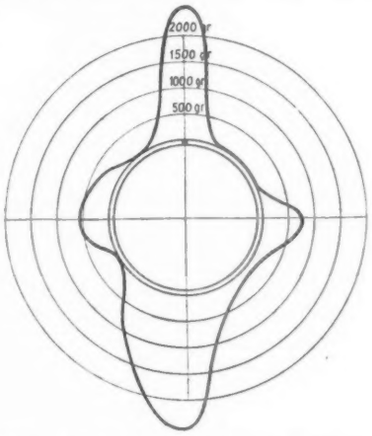

FIG. 8.—RADIAL PRESSURE CURVE OF ECCENTRICALLY-SHAPED PISTON RING.

Curve 5 shows the tendency of the tension in a centrifugally-cast material alloyed with chromium. In addition to chromium, Curve 6 contains nickel and yields a better initial heat resistance, this being perhaps due to the finer grain size; but in its further course the tension falls very rapidly and proves to be less favourable than material No. 5. Curve 7 represents a centrifugally-cast material alloyed with chromium and molybdenum. Curve 8 represents the optimum hitherto obtained; a centrifugally-

cast material with a high percentage of chromium.

Method of Applying Tension

Another factor not without influence on the heat-resistance of a piston ring is the manner in which the tension is applied (Fig. 5). As the result of numerous experiments it has now been possible to demonstrate that a thermally-expanded piston ring is far superior to a hammered-in ring of the same material, this superiority being all the greater according to the height of the running temperature and the fineness of the grain of the piston-ring material.

A further advantage of the thermally-expanded piston-ring is the uniform distribution of radial pressure over the whole periphery, as will be seen by comparing the various "Radial pressure curves" (Figs. 6-11) [1]. These curves were obtained by measuring the radial pressure in a piston ring at 16 points on the periphery, and then connecting these points to circle-ordinates. It is clear that, theoretically, these curves must have a circular shape and that the characteristic curve of a ring becomes poorer in direct proportion to the deviation from the circular form.

Radial Pressure Curves

Fig. 6 shows the course of radial pressure in a heat-treated expanded single ring. The course of the curve approaches fairly closely to the circular form. In Figs. 7 and 8 are shown the curves of a hammered-in piston ring and a ring made by the eccentric process respectively; these curves diverge widely from the circular form (see also p. 134 of reference [10]). It may be argued that during running the rings adapt themselves: they "run themselves in," so that the points of high radial pressure are soon worn down and a balance is quickly established. To verify this, the radial pressure measurements were also made upon worn rings, the wear being brought about artificially by grinding them slightly (Fig. 9); furthermore, really worn rings were tested (Fig. 10) and, finally, the wear was brought about by allowing the rings to "run themselves in" (Fig. 11.) These tests confirm the fact that "running-in" by no means completely equalises the differences in pressure. It mitigates them to a certain extent, but the original characteristic curve is retained. Thus the old experience of the piston-ring manufacturers is confirmed: that eccentric rings do not become round even after repeated grinding.

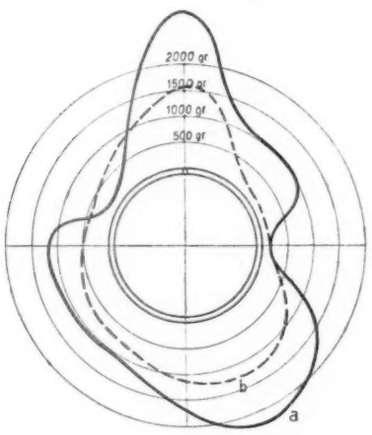

Fig. 9.—Hammered Bushed Piston Ring after Lightly Grinding. (*a*) Radial Pressure Curve before Grinding, and (*b*) after Grinding.

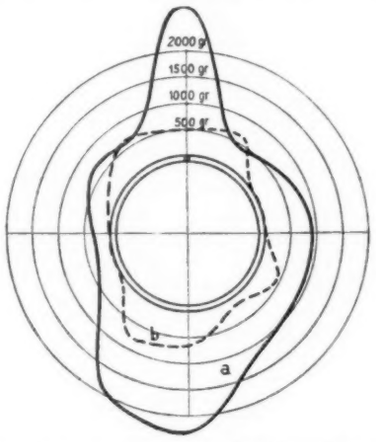

Fig. 10.—Hammered Bushed Piston Ring. (*a*) Radial Pressure Curve of New Rings, and (*b*) Curve for Rings after ½-mm. Wear at Walls.

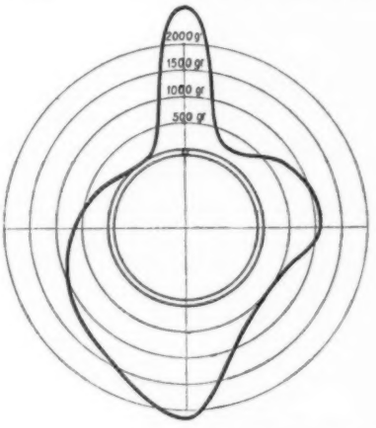

Fig. 11.—Hammered Bushed Piston Ring. Radial Pressure Curve of a Ring after doing 625 Miles.

Testing Methods

In Germany efforts are being made to discover a definitely reliable method of testing piston rings. Such useful specifications as the "B.S.I. 5004 and 4K6 for aircraft material" do not exist in Germany. Wear-testing machines have so far proved a complete failure and can never lead to an impeccable result. An effort has therefore to be made to establish singly the various factors which, together, yield good mileage properties. These factors include: the chemical analysis, the microscopic structure, physical properties, *e.g.*, tensile strength, permanent set, heat-resistance, etc. The modulus of elasticity has only an indirect influence on the mileage properties.

On comparing the above factors it is found that the characteristic curve of a piston ring is rather narrowly limited, but an inference may be drawn as to the effectiveness of a piston ring for the purpose required of it.

In this connection, it should be pointed out that in judging a material its hardness is a thoroughly unreliable guide. Founders can to-day produce grades of cast iron the properties of which vary greatly, although the hardness is the same, that these characteristics cannot be relied upon.

A rapid survey of piston-ring material enables us to determine the so-called "piston-ring hysteresis" (Fig. 12). As ordinate, the bending stress per sq. mm. and as abscissa the width of a gap in a piston ring originally free from stresses are taken. The ring is then subjected to pressure, for closing the ends, up to a given maximum pressure, generally 22 kg./mm.² (14 tons per sq. in.), after which the pressure is brought back to zero and the ring is then loaded in the opposite direction, *i.e.*, for opening under the same loading stress, and the pressure again released. The curve does not then return to the original point. The distance from the starting point indicates the extent of the "permanent set," which is best expressed in percentages of the maximum gap width. The area enclosed by the hysteresis curve corresponds to the loss of tension in the ring. The degree of inclination in the curve depends upon the modulus of elasticity. The higher the modulus the steeper will be the hysteresis curve. The

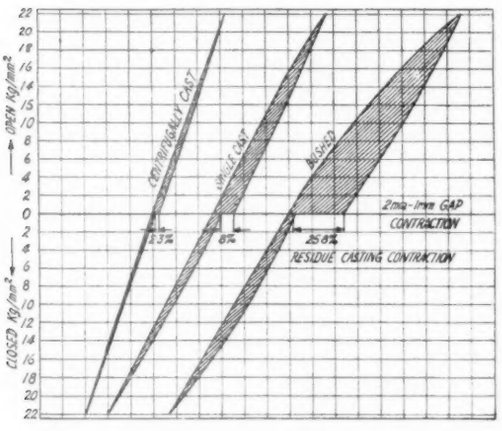

Fig. 12.—Hysteresis Curves of various Piston-Ring Materials.

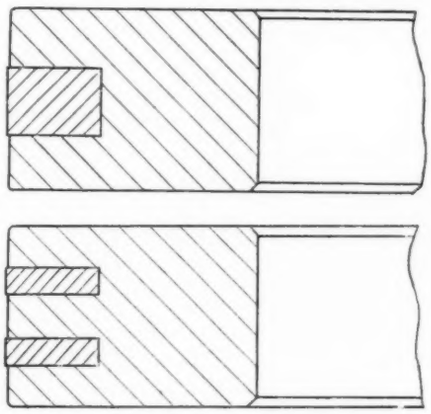

Fig. 13.—Piston Rings with Bronze Liners.

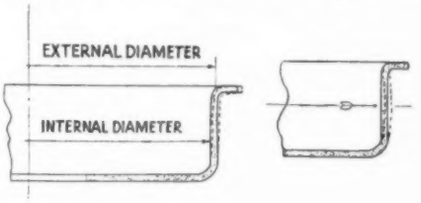

Fig. 14. Fig. 15.

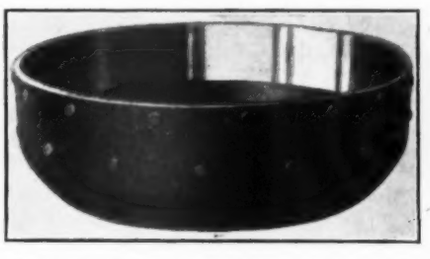

Fig. 16.—Steel Brake Drum fitted with Centrifugally-Cast Liner.

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graphs obtained in this investigation afford very valuable indications as to the nature of the material which, in conjunction with the chemical analysis and the examination of the structure, yield a complete picture.

Efforts have recently been made, both in America and Germany, to obtain exceptionally durable and wear-resisting piston rings by embedding bronze rings in cast-iron rings in such a manner that the bronze will take care of the

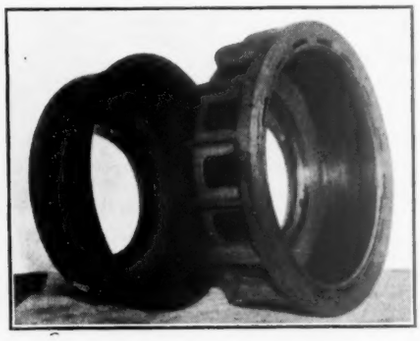

FIG. 17.

actual running conditions, whilst the cast iron will afford the resistance to heat (Fig. 13). In Germany, however, no appreciable advantages have been gained by these rings.

Cylinder Liners

In Germany, moreover, the view is being increasingly adopted that for a good piston ring a suitable cylinder surface is necessary.[2] This is shown by the development of the cylinder liner. In German engines—petrol as well as Diesel—cylinder liners are being used to an increasing extent.

It may be mentioned, however, that hardened liners have so far not been in great demand in

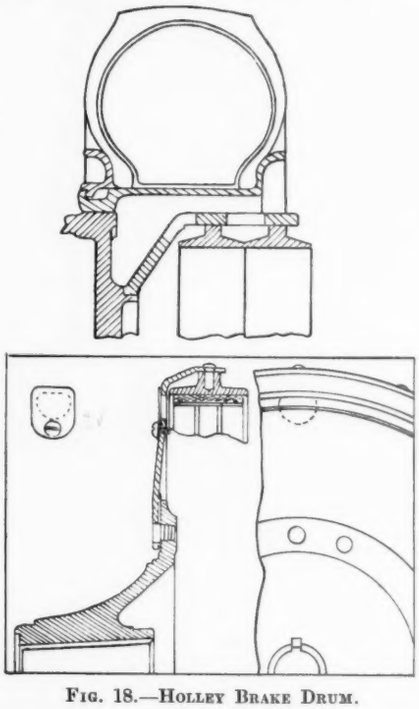

FIG. 18.—HOLLEY BRAKE DRUM.

Germany; while, on the other hand, completely satisfactory results have been obtained by the use of suitably-alloyed, centrifugally-cast liners. While, for ordinary engines, centrifugally-cast materials containing a slight proportion of chromium alloy were found thoroughly satisfactory; centrifugally-cast liners, alloyed with chromium and molybdenum, are preferred for Diesel engines or engines subjected to high stresses, as being more advantageous.

There was a time when it was prophesied that cast iron would be gradually ousted by steel or malleable castings. Since then, cast iron has provided many surprises; from the unreliable cast iron of an earlier period noteworthy high-grade materials have been created. In respect of resistance to wear, minimum sensitiveness to notching and shock-absorbing capacity, cast iron is immensely superior to steel.

Owing to its advantages, high-grade cast iron is being increasingly used in motor vehicles. One need only mention the crankshafts and cam-

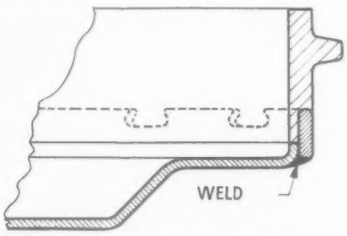

FIG. 19.—AMERICAN "CENTRICAST" BRAKE DRUM.

shafts of alloyed cast iron which are being adopted to an ever-increasing extent.

Brake Drums

In the case of brake drums cast iron has already given excellent results. For quite a number of years the standard, pressed-sheet-steel drums were considered adequate, but as improvements, necessitated by the increase in speeds, were introduced in brakes, it was felt that a better material was needed for the brake drums. The great disadvantage of sheet-steel drums is that they expand considerably when subjected to heavy brake pressure and superheating and become out of truth. In most cases this expansion is very irregularly distributed, and occurs mainly at the flange diameter (bell-mouth effect, Fig. 14), or else the braking surface sags (barrel effect, Fig. 15). Moreover, the brake lining frequently tears bits of steel out of the braking surface; these pieces remain adhering in the lining and cut furrows in the braking surface which, once formed, quickly become deeper and cause rapid wear. In addition, sheet-steel drums, which are very thin *per se*, are highly resilient, and it has been found that over 50 per cent. of the pedal stroke is expended in overcoming this resilience.

In the search for a material which should not show the above-mentioned disadvantages it was soon proved that cast iron was far superior to

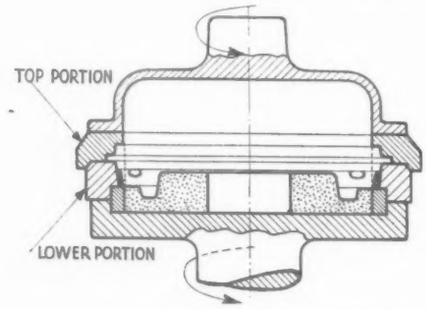

FIG. 20.—VERTICAL CENTRIFUGALLY-CAST BRAKE DRUM WITH INSERTED STEEL COMPONENT.

all other materials, including cast steel, improved sheet-steel, etc. Owing to its rigidity, the cast-iron drum never loses its shape even when subjected to maximum heating, and thus it maintains a uniform braking effect. With cast iron the braking effect is very powerful and instantaneous and, above all, very uniform, as no resilient effect is set up, so that cast iron owing to the properties inherent in the material itself, *e.g.*, graphite striæ and higher friction coefficient, constitutes a very good braking surface. As cast iron is highly resistant to wear, brake drums made of this material have a much longer life than steel drums.

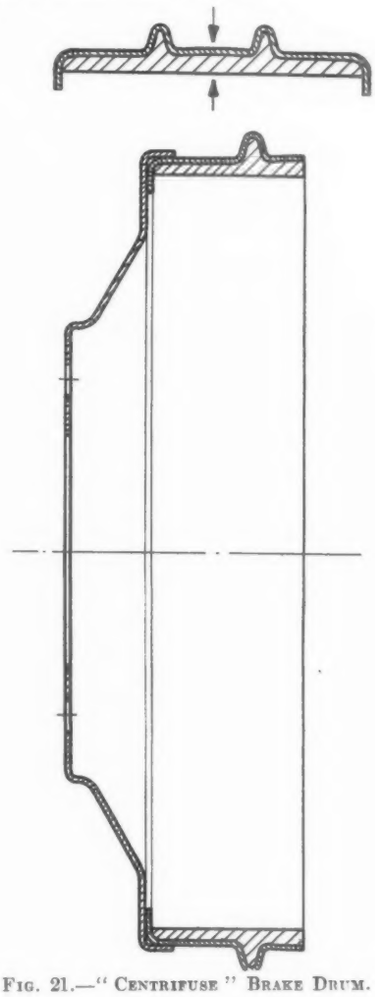

FIG. 21.—"CENTRIFUSE" BRAKE DRUM.

The cast-iron drums has, however, one great disadvantage. In order to ensure adequate tensile strength it has to be made considerably heavier than a sheet-steel drum of the same size. Its use was therefore limited for the time being to heavy, slow-running lorries, and for these it has proved satisfactory in every respect, particularly in the United States, during the last 8 or 10 years. Although the properties of

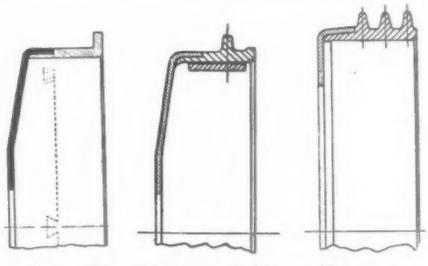

FIG. 22.—"CENTRIT" BRAKE DRUMS.

the cast-iron brake drum have been substantially enhanced by the improved quality of the metal, the use of highly developed melting processes and the addition of chromium, nickel or molybdenum, none of the many brake drums which have appeared under their various trade names is able to show even approximately the

low weight of the sheet-steel drum. This was, however, one of the main factors which made the use of cast-iron drums impossible for high-speed vehicles.

Combined Iron and Steel Drum

A happy combination of the properties of sheet steel and those of cast iron was incorporated in the Centrit brake drum made by the author's firm, Messrs. Alfred Teves, of Frankfurt-am-Main, which appeared in Germany about two years ago [2]. Before giving a detailed description of this drum, a brief summary showing the evolution of the combined steel and cast-iron brake drum should be of interest to the founder, as also to the motor engineer, particularly as such a summary has not hitherto, so far as the author is aware, been available. It is expressly pointed out, however, that this summary does not claim to be complete; on the contrary, only a few practical tests of outstanding interest will be mentioned.

Fig. 23.—Photomicrograph of Weld between Cast Iron and Steel, Etched. × 200.

(1) The first experiments with combined drums appear to have been made in England, where worn steel drums were bored out and then provided with a centrifugally-cast liner as is shown in Fig. 16 [17]. Apart from the fact that this process is very expensive, it was impossible to adopt this drum for quantity production, owing to its poor transmission of heat. The heat engendered by braking accumulates in the liner and is transmitted only very gradually to the outer steel casing. This gave rise to two disadvantages: Firstly, the liner, under continuous brake loading, becomes too hot, so that cracks appear on the braking surface. Secondly, owing to the permanent differences in temperature the liner works loose, so that if it were not secured with copper rivets it would rotate within the steel drum.

(2) In order to facilitate the heat transmission of the liners, an American concern provided the outer steel casing with openings and cooling ribs, but no material improvement was thereby effected. The brake drum shown in Fig. 17 had the additional disadvantage of comparatively heavy weight.

(3) Early in 1930 an entirely new combination was evolved in America. This was the Holley brake drum (see Fig. 18), which consisted of a sheet-steel holder with a brake ring of approximately T-shaped section fixed therein.[18] It was claimed for this combination that it entirely eliminated the "bell-shape" effect; that its weight exceeded by only a little that of a sheet-steel drum; and that it enabled an excellent transmission of heat to take place. The brake ring was cast by the well-known Holley "permanent-mould" process and treated accordingly. It is known that this casting is nearly 100 per cent. ferritic, but such cast iron is not resistant to wear.

(4) In 1931, in Newark, N.J., a process became known in which worn Ford sheet-steel brake drums were provided with a centrifugally-cast rim of cast iron. These drums were called "Centricast" brake drums, a name borrowed from the English, but they had nothing to do with the English firm. The drum consisted substantially of a cast-iron rim, with an inserted ring of steel as shown in Fig. 19. The steel ring was provided with semi-circular notches in order to prevent its working loose. As will be seen from Fig. 19, the back of the old Ford drum was electrically welded on to the steel rim. The process used for the pouring of the steel rim is, owing to its unique character, sufficiently interesting to deserve elucidation.

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In the mould rotating about the vertical axis (Fig. 20) was located a revolving gate (Rille) of graphite or fireproof brick.[19] The flat iron, welded to a closed ring, was placed in the cast-iron mould, and while the machine was standing the pouring gate was filled with molten iron. By connecting the motor, which was coupled directly to the mould, the iron was then thrown out of the gate to meet with the full force of the 900 to 1,000 revolutions of the mild-steel band, which was instantly heated to white heat and welded to the cast iron. As the cast-iron rings solidify white (cementitic) at the edges, owing to the iron mould, they had to be heated until soft before being further worked up.

(5) The "Centrifuse" drum—a further type—had an extraordinary success in America.[20 21 22] This might be described as a "multiple assembled" drum. Into a ring previously heated to bright red (Fig. 21) a given quantity of iron was poured, in accordance with the centrifugal-casting process. After cooling, the duplex ring thus obtained was divided and then fixed to a suitable disc by spot welding.[22] Thus there is again, substantially, a cast-iron ring located in a mild-steel drum. The essential difference between the "Centrifuse" brake drum and the English type, with liner, mentioned under (1), is that the heat transmission in the former is incomparably better. This is due to the fact that steel and cast iron having been united by welding a far-better transmission of heat from cast iron to steel is obtained. In many millions of brake drums the "Centrifuse" drum has given excellent results.

Fig. 24.—"Centrit" Brake Drums.

For European conditions, however, the "Centrifuse" brake drum is too dear. First of all the casing has to be rolled out of one piece, so as to enable it, as the short-circuited secondary coil of a transformer, to be brought to bright-red heat in 15 to 20 seconds and thus render possible the welding-on of the cast iron. In addition, the back guard of the drum has to be made separately and then fixed to the brake rim. The equipment required for this purpose is exceedingly comprehensive and expensive—to say nothing of the cost of the drum itself. The vast numbers produced in America have rendered possible the adoption of this process.

The "Centrit" brake drum, made in Germany, represents a further improvement in the combined steel and cast-iron brake drum. Here simplicity of manufacture and appropriate shaping go hand in hand (Fig. 22). The drum consists essentially of two parts: the sheet-steel back—the flange of which is provided with dovetailed-shaped notches so as to facilitate intimate welding and obtain increased security—and a cast-iron rim. As will be seen from Fig. 23, the weld between cast iron and steel is a thoroughly intimate one. A real fusion takes place and, as is clearly shown, the carbon in the cast iron penetrates into the steel to a considerable depth. The effect is a weld between the two metals which may be compared to a real merging, whereby both parts are connected.

(*Concluded on page* 104.)

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Some Notes on Ingot Moulds

By T. SWINDEN, D.Met., and G. R. BOLSOVER, F.Inst.P.

(*Concluded from page 83.*)

Care and Use of Moulds

It was stated, in connection with personal experience in the trial of some German moulds, that the life of the German moulds under specific conditions of use gave a life of 130 casts, compared with 200 casts being obtained in Germany from similar moulds. This at once indicates the importance of the method in which moulds are prepared for use and treated between consecutive casting. The basic principles underlying the care of moulds would seem to fall under two headings; firstly, some method to keep down the temperature to which the moulds are heated in service, and secondly, the treatment or preparation of the mould surface to minimise deterioration by splashing and "wetting." As regards the former, practice varies considerably. In some cases moulds are quenched in

Fig. 2.—Corner Crack Defect at Top End.

water after use, in other cases sprayed with water, in some allowed to stand for specified times on grids, and in some cases supplied with forced draught, while others rely on allowing the moulds to cool normally for not less than a specified time. Shop facilities in many cases preclude the attainment of all one would desire in regard to the resting period between casting, but such experiments as the authors have made by allowing the moulds to cool on special grids indicates a definite advantage from such treatment.

Morawa (*loc. cit.*) quotes detailed experiments in regard to the method of cooling, and finds that air-cooled moulds give the best life, but this entails a large number of moulds and much space for their accommodation. This item must also be bound up closely with the actual composition and structure of the mould metal, in that some types of moulds would suffer much more severely than others if cooled quickly, for example, by immersion in water. It is probably clear, however, that deterioration by a breakdown of the structure of the iron must be minimised if steps are taken to reduce the maximum temperature to which the moulds are raised in service. The spacing of the moulds in setting the casting pit is obviously an important factor in this direction. A practice has recently been developed in Sweden whereby the ingot is pushed upwards in the mould as soon as it is strong enough to be moved, and allowed to rest in the mould after rotating, so that the corners re-engage with the sides of the mould. It is stated that this practice definitely results in an improvement of mould life and incidentally in the resulting product of the ingot.

Mould Facings

Reverting to the second point, particularly if a pure soft hematite mould is being used, it is desirable that the surface shall be protected as far as possible so that the ingot will strip clean, both from the point of view of improving the ingot surface and also to prevent small pieces of mould metal being pulled away when the ingot is stripped. Numerous preparations have been used with this object of preventing steel from "wetting" the surface of the mould. These include dehydrated tar, usually thinned down somewhat, the old practice of "reeking" by burning creosote oil in the bottom of the mould, rubbing with oily waste, clay wash, aluminium paint, etc. To these are to be added a number of proprietary mould varnishes, which at present are receiving a certain measure of support on the Continent and in this country. It is quite impossible to lay down any fixed rule as to the most desirable method of preparing the inner surface of the mould. This depends essentially on the size and type of ingot being cast. It can be said, however, that in Stocksbridge practice, oiling has been found superior to the other methods tried, and that if used with discretion tar-spraying could be used with advantage in plants such as Workington and Templeborough. A word of warning should be added in regard to the use of tar, either by spraying or swabbing, and that is that great care is necessary to avoid using an excess whereby a pool of tar drains to the bottom of the mould. Under such circumstances, the loss on the resulting ingot far outweighs the advantages. In heavier ingots, particularly where uphill casting is employed, it has not been found necessary to prepare the mould by any of these methods.

The use of a stripping machine gives a definite increase in the life of moulds, apart from the fact of being able to remove ingots from moulds which would otherwise have to be discarded, in that the bumping of moulds to release "stickers" is a contributory cause of moulds failing by cracking.

How Do Moulds Fail?

Considering this matter first from the shop point of view, personal experience which has been very carefully checked up, is that moulds fail mainly through major cracking rather than from breakdown of the mould surface. The authors noted with interest the reference by Mr. Léonard (*loc. cit.*) to this subject, where it was stated that slab moulds failed through cracks, whilst polygonal moulds finish their useful life through the deterioration of their internal surfaces. It is clearly necessary therefore, to keep in mind the type of mould when speaking of the relative merits of the different factors resulting in the final failure of the mould. Speaking generally, it is clear that for any given type of mould, if a hard, brittle iron is used, and particularly if it is put into service in a state of stress, it is reasonable to expect that such a mould will crack at an early stage in its life. On the other hand, if the mould be made of very soft iron, and particularly if the graphite is coarse and flakey, then deterioration will be more rapid on the well-established principles of oxide penetration, along the graphite plates.

Fig. 3.—Showing the Development of Crack round the Lug.

It seems germane to interpose here that in personal opinion the stresses in the ingot mould as-cast appear to be of a serious order, and the effect has manifested itself in some cases in a rather extraordinary way. Many years ago it was found that, in casting 12-sided tyre ingots

Fig. 4.—Showing a Typical Transverse Crack.

of 14-, 17- and 19-in. dia., the first ingot from a new mould was almost invariably cracked vertically in one or more of the corners. If the moulds were annealed at about 800 deg. C. before use, the phenomenon was avoided, and the practice was therefore adopted of always casting an ingot of slag into new moulds before using them for steel. If the stresses in the

mould had such an effect on the resulting ingot, it is clear that the mould requires to be regarded carefully from this point of view if the maximum life is to be obtained. In looking at written returns from the melting shop, it is usual to see the word "cracked" as the reason for discarding, but it is necessary to analyse the meaning of the term in considerable detail. Major cracking often occurs at the top end of the mould where, presumably, it is coolest, and, for example, in the case of 2-ton square moulds, it definitely appears to commence from the outside of the mould. It would appear that, as a result of internal stresses, and more particularly the fact that the iron cannot accommodate itself sufficiently quickly to the increase of temperature from below, cracking takes place. If the mould be fitted with liner bricks at the top or accommodates a feeder head, it may continue to be used for a long time after cracking has started, but it is very often finally thrown out because this crack has developed through the wall, and it is unsafe for further use. The larger moulds appear to fail mainly through cracks on the face, starting about the middle where the mould gets hottest and travelling downwards, while in a number of cases the transverse crack across the face occurs long before the surface has seriously deteriorated. A few illustrations are added typical of some of these defects. Fig. 2 shows a typical corner crack at the top of a mould. Fig. 3 shows a crack round the lug clearly caused by unequal expansion, while Fig. 4 shows a mould which has failed through a transverse crack.

Fig. 5.—Ingot Mould Scrapped through a Defective Surface.

If a mould has not cracked, it continues in use until the surface has deteriorated to the extent of producing bad-surfaced ingots not acceptable to the mill, or ultimately on account of bad surface the ingot cannot be stripped and the mould requires to be broken off. There are, of course, the cases where moulds are scrapped with a very short life, due to bad teeming, when the side of the mould may be scored away, and rough handling in the shop, giving rise to cracking.

Sometimes the bad surface clearly develops from improper foundry conditions, and results in local deterioration, as shown in Figs. 5 and 6. Otherwise the surface gradually develops a crazed effect, as shown in Figs. 7 and 8, and this ultimately develops into transverse cracks, as shown in Fig. 9. Rapid deterioration round the "plug hole" is a common failing, as shown in Fig. 10. The mould metal is often weak in this position.

Microscopical examination through the section of used moulds is a most entertaining exercise. The authors have nothing new to add to the accepted evidence on this point, but it is certainly curious to know the wide difference in the way in which local fields have deteriorated. In some cases the spaces occupied by the graphite flakes are surrounded by a grey constituent, which is no doubt an oxidation product, and the whole of the carbide has been removed. In other fields it is possible to get perfect pearlite right up to the edge of the oxidised zone.

It has been proved by analysis that there is a slight increase in the sulphur content of the inner surface, possibly occasioned by the rapid interaction of oxide when the moulds are not in use. Careful observation has indicated that, for example, in the case of the 21-in. S.C.T. mould at Templeborough, surface deterioration does not become seriously apparent until after about 70 casts, following which it develops, first gradually and then with increasing rapidity, until the mould is unfit for service. Personal experience, therefore, leads to the following comments under this heading.

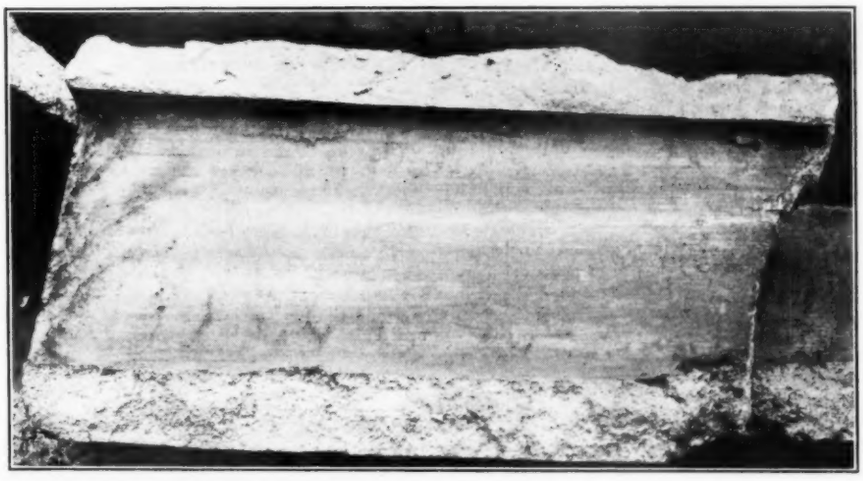

Fig. 6.—The "Shelly Corner" Defect.

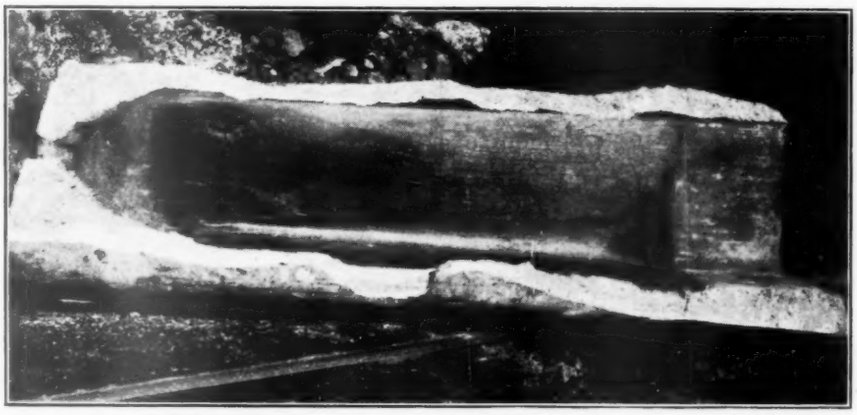

Fig. 7.—Showing the Crazed Surface, which has Developed after Extensive Use.

Interim Summary of Cracking

A careful survey of the causes of mould failure indicates that the majority of moulds fail through what can be termed "major cracking," and that the principal factor causing major cracking is the inability of the material to accommodate itself to the unequal expansion which takes place when the mould is used. Mould design can assist in obviating premature failure through certain types of cracks (*e.g.*, corner cracks at the top end) while conditions of use (*e.g.*, ingot spacing in casting) as well as design, will improve moulds as regards transverse-face cracking. An improvement in the quality of the material to enable it better to withstand thermal shock must also be an important line of development. Assuming the mould does not crack, but gradually develops a crazed surface due to the repeated heating and cooling, then clearly the physical characteristics of the mould metal must be looked to primarily to improve the life, together with such a system of use as to limit as far as possible the maximum temperature to which the moulds are heated in service.

Steel Ingot Moulds

It must occur to everyone that, speaking metallurgically, mild steel ought to be far better suited than cast iron for ingot moulds. Steel moulds have, of course, been used from time to time and certain reports are available, stating extraordi-

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nary good lives, in some cases up to 700 casts. Steel moulds ought strongly to withstand failure through crazing or cracking, assuming they are made of normal mild steel. Personal experience is very limited, but a trial made some years ago was certainly not satisfactory. The trouble is, of course, that the steel mould distorts badly, and all efforts to reinforce by bends, ribs, etc., have failed to establish the steel mould as a serious competitor. The initial cost would be higher, but if satisfactory lives of the order of 500 to 700 could be obtained, it would undoubtedly become a serious competitor to the iron mould.

The simple explanation appears to be that owing to the greater elasticity of the steel mould, it distorts to such an extent as to make it impossible to cast a regular-shaped ingot and, what is more important, to strip the ingot from the mould after a comparatively short life.

Artificial means of keeping the mould cool have, of course, been tried. Many years ago, the authors experimented with a system of circulating high-pressure air round the outside mould. Water-cooled steel moulds have been suggested, but the only system of which we have knowledge, which has achieved a certain amount of success, is the water-cooled copper mould developed by Rohn* at Hanau. The exact design has been worked out very accurately and the authors have actually seen moulds that have made up to 4,000 ingots and have examined ingots cast in such moulds.

The cost of the equipment for a production shop would, of course, be extremely high, and one must always bear in mind the risk of damage through mishandling. It is on this account, no doubt, that the system of using water-cooled copper moulds has not developed to a greater extent.

No attempt has been made in this Paper to give any extensive references to the numerous admirable Papers that have been written on this subject, but rather an endeavour has been made to state in simple language some facts concerning experience obtained over a number of years in the plants of the United Steel Companies, Limited. Those interested are, no doubt, well conversant with contemporary work on the subject, and particular reference must be made to the work that has been done by the Heterogeneity of Steel Ingots Committee in conjunction with the Cast Iron Research Association. Further work that is going on now in collaboration with the British Federation of Iron and Steel Manufacturers will probably result in a sound development in the subject of ingot-mould manufacture.

The authors would like to close, however, on the note with which this Paper was opened, namely, that the quality of the steel ingot must be the first consideration, and secondly, that the value of an improved mould to the steelmaker, judged from the cost-per-ton standpoint, must not be over-exaggerated.

In conclusion, the authors record their thanks to the United Steel Companies, Limited, for permission to use the information given in this Paper, which has been collected through the goodwill of the various staffs of the respective works.

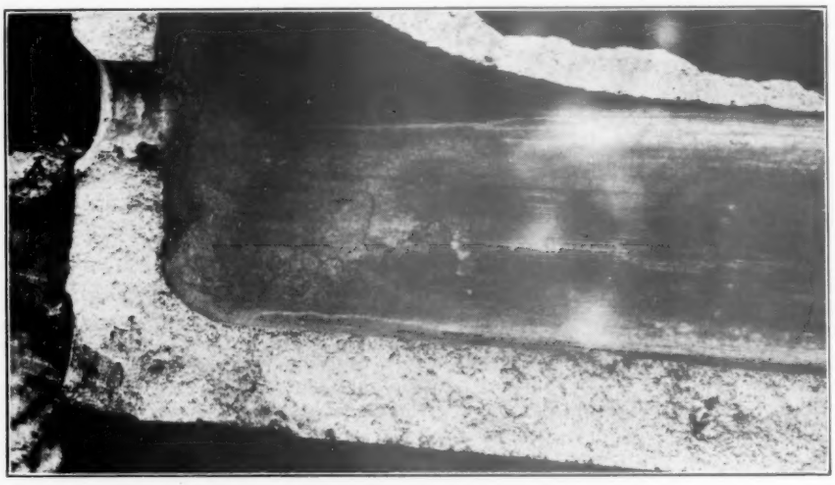

Fig. 8 shows a Crazed Surface Developing Prematurely.

Fig. 9.—Enlarged Photograph of Crazing Developing into Cracks.

Fig. 10.—Showing Deterioration Round the Centre Runner Hole.

* "Zeit. f. Metalkunde," 12/1927.

German Progress in Piston Rings, Brake Drums and other Automobile Castings

(*Concluded from page* 101.)

Thus it is only necessary to make one pressed component. This pressed component does not require to be heated, nor is it necessary to effect a subsequent welding of the back on to the brake rim. The exceptional advantages of the "Centrit" brake drum won the unanimous appreciation of experts, and a number of the leading German motor-car manufacturers have adopted it for quantity installation in their vehicles. It is interesting to note that the advantages of the "Centrit" brake drum are being utilised not only for large vehicles but also for small cars, *e.g.*, the "Adler Trumpf Junior," in which it is installed as standard drum. This shows that the combined centrifugally-cast brake drum need not be regarded as a prerogative of large, costly cars. It may be added that, as compared with the all-cast-iron drum, the combined drum not only possesses the advantage of greater reliability and lightness, but is also much more advantageous as regards machining. In the all-cast-iron drum the back requires to be machined on both sides, but this is not necessary in the case of the steel back of the "Centrit" drum. Furthermore, when riveting or screwing this drum on to the wheel hub there is no danger of its splitting, as so often happens in the case of cast-iron drums, particularly where it is a matter of quantity production on a considerable scale so that very great care cannot be counted upon.

"Centrit" brake drums have been, and are being, produced in large quantities in Germany (Fig. 24), and the experience of the past two years justifies the presumption that this type of drum will also find favour in other countries. In this connection, it should be mentioned that a leading foundry for centrifugal castings in England is already being equipped for the production of the "Centrit" brake drum.[24] The advantages which had been claimed for the "Centrit" brake drum have been fully realised in the large numbers which have been installed in the last two years. And when it is added that not a single case is known in which a drum has been fractured, this goes to show the exceptional reliability of this brake drum.

The author wishes to express his indebtedness to Dr. Teves, of Alfred Teves, G.m.b.H., Frankfurt-am-Main, for permission to publish the results referred to in this Paper.

Fifty men began work last week at Redheugh Foundry, Dunston, Gateshead, which has been closed for more than 11 years. The foundry has been reopened by a new company, A.R.M. (Acid Resisting Metals), Limited, of London, who are at work on a new light acid-resisting alloy.

Alloyed Steel Foundry Practice

PROPERTIES OF OXYGEN-FREE STEEL

Dr. W. H. Hatfield's Paper, which was presented to the Sheffield Conference of the Institute of British Foundrymen, gave rise to a very interesting discussion. It was opened by Dr. P. Longmuir, M.B.E. (Past-President). He congratulated Dr. Hatfield on his excellent survey of alloy-steel castings, and said that the figures given with regard to the physical properties of these castings were, as Dr. Hatfield had said, conservative. The four tables in the Paper covered the field admirably, and the physical values given towards the end were of very real utility. Emphasising his point that the maximum values given in respect of the physical properties in Table I were conservative, Dr. Longmuir said independent tests on the 18/8 chromium-nickel steel as produced under Dr. Hatfield's supervision, the tests extending over many months, showed that those values were very regularly exceeded. It was not often that, when examining alloy castings of this character, one obtained such conformity as between the makers' results and the results of independent checks. Dr. Longmuir also congratulated Dr. Hatfield on his presentation of the treatments given, which constituted perhaps the most valuable feature of the Paper. Although treatments were more widely applied to castings than was generally recognised, very few of the firms who treated the castings had published their results. Indeed, to some extent in steel-foundry circles those treatments were still regarded as deep, dark, and mysterious secrets. The advice given in the Paper with regard to moulding was also excellent, and perhaps Dr. Hatfield would forgive him if he said that that advice could be carried to other than alloy-steel castings.

Value of Co-operative Research

Dr. T. Swinden also stressed the value of the Papers which Dr. Hatfield had contributed to the mechanical engineers, automobile engineers, aeronautical engineers, and various other bodies, and the generosity of Dr. Hatfield and his company in putting forward such data. One usually expected from Dr. Hatfield Papers such as that which he now presented, and which were simply invaluable. It was difficult to discuss such a Paper, because it was a statement of carefully-considered facts, and it was of great benefit to have in so concise a form reliable information concerning these various types of alloy castings.

Dr. Swinden also reminded the meeting, as had Dr. Hatfield, in the course of the discussion on ingot moulds that morning, that a Joint Committee on Steel Castings was operating; and as a vice-chairman of two such joint committees, Dr. Swinden emphasised that some of the steel-makers possessing considerable resources were placing before the community, at considerable expense, a great deal of valuable information. As Dr. Hatfield had stated in the last paragraph of his Paper, it was important to fill in the gaps in the information available; the filling of those gaps was rightly the business of the whole community, and it was justifiable to urge that all interested parties should co-ordinate their data and place them before the Committee, on which they had ample opportunity for representation, and so help to improve the whole industry of the country.

Influence of Alloyed Steel on Carbon Steel Practice

Mr. C. W. D. Townsend could not refrain from associating the information contained in Dr. Hatfield's paper with the statement made by Sir William Larke in the course of the "Edward Williams" Lecture, in which he had visualised the results of using steels having a strength three times as great as that of the steels available at the present time. The paper by Dr. Hatfield was helping to achieve that end, by placing on record definite data which could be used by all who were interested. He had set an example, which, if followed by other firms who possessed special information, would rapidly bring them to the stage at which they should be able to produce such steels as Sir William Larke had visualised, the production of which would, of course, increase foundry problems. Dr. Hatfield not only appreciated the scientific and technical difficulties, but also the human ones. Practical foundrymen recognised that they must develop a standard of technique in line with the development of the various steels. The multiplication of the steels produced in the steel foundry had added vastly to foundrymen's problems; it had also had a reflex action on the manufacture of carbon steel castings, inasmuch as it had brought forward rapidly those problems which had to be overcome in connection with alloy steels, thus helping the carbon steel casting manufacturer to reach a position which otherwise he might not have reached for many years to come. The paper constituted a milestone in the development of the technique of the production of alloy steel which could be cast into articles for use in the engineering trades.

Properties of Steels Melted *in Vacuo*

Professor J. H. Andrew (Dean of the Faculty of Metallurgy, University of Sheffield), in thanking Dr. Hatfield for the paper, said that very frequently in his Lectures he used Dr. Hatfield's results and had found them extremely useful. He asked if Dr. Hatfield considered that a cast structure, properly heat treated, would give results equal to those of a forging. Experience in the industry, in conducting tests on material from a 40-ton ingot which had not been subjected to forging, was that by successful heat treatment, results were obtained equal to, and in some cases better than, those obtained from forged material.

It was pleasing that Dr. Hatfield had emphasised the importance of the initial cast structure, for he (Professor Andrew) imagined that the final properties of a casting depended upon initial structure to a greater extent than was realised by many people.

Reference was also made to the possibilities of vacuum melting, it being suggested that in order to make perfect steel we would have to melt *in vacuo*. Vacuum melting gave a loss of carbon from 15 to 18 per cent., there was loss of practically the whole of the manganese, and one eliminated the oxygen. He had found that if the steel were deprived of all the oxygen, without effecting the other elements, the tensile strength was reduced by from 5 to 15 tons. He was beginning to think that the oxygen was an essential ingredient in steel, in certain amounts.

Finally, Professor Andrew asked whether it was possible to remove the castings from the moulds whilst they were hot and place them in a soaking pit, in order to avoid contraction stresses during cooling.

Sand Data Required

Mr. N. D. Ridsdale asked if Dr. Hatfield could give, in addition to the very useful collection of data contained in the paper, some actual figures on the properties of the moulding sands to which reference had been made. It was stated in the paper that in general the sands should have high permeability, and so forth; now that such properties could be measured readily it seemed a pity not to have also some actual data as to the permeability number, and bond strength, say on the A.F.A. scale, in respect of both the green and the dry sands which Dr. Hatfield had used. Mr. Ridsdale pointed out that if Dr. Hatfield had no facilities, he could obtain data, through the Secretaries of the Branches of the Institute, as the result of the questionnaire issued by the Sub-Committee on Sands and Refractories.

Annealing Temperature and Fluidity

Mr. J. E. Mercer (Stockton) thought practical foundrymen would agree that the tables which Dr. Hatfield has drawn up were a good practical guide to those engaged in the steel and alloy castings trade. Mr. Mercer referred to the high-permeability steel mentioned in one of the tables, which, of course, has a very low carbon content. The annealing temperature was given as 900 deg. C. From personal experience Mr. Mercer did not consider this possible. Could Dr. Hatfield give his opinion on this?

Discussing the fluidity of steel, Mr. Mercer questioned a statement in the Paper concerning low-carbon steel not being as fluid as a steel containing 0.4 to 0.6 per cent. carbon. In his opinion, the fluidity depended firstly on the quality of material charged into the furnace, and secondly upon the length of time the steel remained in the furnace. There was no real reason why the lower-carbon steel should not be as fluid as the one with the higher carbon content.

AUTHOR'S REPLY

Co-operative Research

Dr. Hatfield said that he was gratified by the discussion, and it was also a real pleasure that the discussion had been opened by Dr. Longmuir, one of the Institute's earliest Presidents, whose comments were very much appreciated. He also thanked Dr. Swinden for having emphasised the general idea of collective research. It would be agreed that if ours was a mechanical civilisation, and depended on the application of science to industry, and the development of large manufacturing units, surely those large units, such as Brown-Firth, the United Steel Companies, the English Steel Corporation, the General Electric Company, and so on, having big laboratories financed by public money—and it was public money if one analysed the shareholdings—should be generous, and should put before the public at large the findings of their research. In a number of outstanding cases that had been done, but, as Dr. Swinden had said, it was not correct and proper that individual companies should be expected to do all the investigatory work for industry. On that assumption the British Iron and Steel Federation, through its Research Council, was endeavouring to provide a mechanism whereby the fundamental research for the whole industry could be done with the aid of collective resources. That was a very necessary phase in the evolution of the steel industry, and he believed it applied more or less to other industries. But he believed the steel industry was setting the pace, and he appealed to all present to do all they could to facilitate and encourage this policy of collectivism and mutual help. The endeavour was to arrive at a condition of things where there was mutual help and collectivism on matters of common interest, whilst at the same time reserving sufficient individuality to the constituent companies, so giving full play to private enterprise. That was a rather British spirit of compromise to fit in with the evolution of modern civilisation. He also expressed appreciation of Mr. Townsend's remarks and agreed with him that the greater study necessary to develop alloy steels must result in the great improvement of mild-steel castings also.

Cast Structures Unequal to Forged

With regard to Prof. Andrew's question as to whether good cast steel could give a performance equally as reliable as forged steel, the answer was, quite dogmatically, "No." The reason was that in making a casting one poured liquid steel into any shape the engineer might

have in mind. Even if one subordinated everything else to the production of the most simple form of ingot, it was extremely difficult to be absolutely sure that one produced a perfectly sound, solid and homogeneous piece of steel. In ingot manufacture one was making a standard design all the time, there being only one object, *i.e.*, to produce a form in which the steel was free from defects, everything else being subordinated to that. But, as the work of the Committee on the Heterogeneity of Steel Ingots had shown, perfection had not yet been attained. How could one expect to meet the difficulties, therefore, if one cast any old shape with liquid steel and allowed it to freeze? For absolute reliability there was everything to be said in favour of forgings as distinct from castings. The point was, however, that the economics of the problem would not in most cases permit of the expense of forging; further, as was evidenced by many Papers presented before various Institutions, the steelfounder was, with time, producing very tolerable castings. He had no wish to depreciate in any sense the reliability of steel castings, but having been asked a definite question, he must answer it in this way, and he considered that answer was final.

Oxygen-Free Steels

With regard to oxygen in steel, he was glad that Prof. Andrew had himself announced the results of the important work he had been doing lately, and which would shortly see daylight as a section of the next Report of the Committee on the Heterogeneity of Steel Ingots. He believed that Prof. Andrew and his collaborators by that work had made a very definite step forward in regard to knowledge; it would appear that the presence of gases was normal in steel, and that if they were taken out one was producing an abnormal material, which Prof. Andrew had found possessed properties entirely dissimilar from those of material from which the gases had not been eliminated. This was a very interesting piece of work.

The removal of castings from the mould while hot and placing them into the furnace was in fact practised; the technology of the special steels must be understood, and all such precautions were taken.

In reply to Mr. Ridsdale, he said he was fully aware of various methods of evaluating sands. Those methods were used, but he had not referred to them in the Paper because they were rather outside its scope, and he had not the time at his disposal to deal with that phase of the matter.

The question raised by Mr. Mercer, as to whether the structure of a high-permeability low-carbon steel casting could be broken down at a temperature of 900 deg. C., depended entirely upon the interpretation of the phrase "broken down." But Dr. Hatfield felt that the answer was "No." A simple treatment at 900 deg. C. did not result in producing a perfectly broken-down structure.

Fluidity

The problem of fluidity was a very wide one. The Steel Castings Committee at the present time was faced with the fact that, important as was the investigation of that problem, it had not yet arrived at a quantitative works method of determining the degree of fluidity—a method which could be used from one works to another, so that the fluidity of a particular steel at a particular temperature in one works could be compared with that of the steel under the same conditions in another works. They all believed that nominally the same steel at a given casting temperature could possess widely-different degrees of fluidity, and it was very possible for a higher-carbon steel having a lower melting point to "appear" to have a less degree of fluidity than a milder steel having a higher freezing temperature. Therefore, he could not answer the question.

The Check to Scrap Imports

By a METAL DEALER

Consumers and merchants interested in the scrap-metal trade in this country are rather envious of the lead and spelter interests who have succeeded in getting their case considered by the Import Duties Advisory Committee even though the negotiations towards the alteration of the 10 per cent. duty are proving to be very prolonged. Ever since in March, 1932, a 10 per cent. *ad valorem* duty was imposed on imports of non-ferrous metal products the scrap dealers in this country have had a pretty thin time, for the wording of the Act has unfortunately led to action by the Customs calculated to check business in a most irritating manner. The Act says that material "fit only for the recovery of metal" shall come in free and the ambiguity of this phrase has been a constant source of trouble to Customs officials, importers and manufacturers alike, but until matters are put on a clearer footing it is hopeless to expect any improvement.

Since scrap is made up for the most part of what has been called "rejects from the manufacturing system," it is obvious that in it will be found objects quite recognisable as articles in everyday use, and herein lies the cause of much of the trouble which has arisen. On the very briefest consideration it is evident that articles which have enjoyed existence among humanity must be sorely battered, indeed, if they are to be described as quite unfit for anything except the melting pot. Who is to decide this difficult query? Not the Customs officials, for if there is any doubt, and there usually is, they are not going to run the risk of giving a wrong decision. After all, why should they, for although smuggling may not be the popular pastime it once was, the adoption of a system of protective tariffs in this country offers an opportunity to unscrupulous people to bring in free of duty articles, which instead of being melted down, will be saved from the fiery ordeal and given a further lease of life, either in their old job or in one very similar to it. The risk is there and it is no use denying it; the question is, can any way round this difficulty be found?

Representatives of the scrap metal trade have from time to time visited the Customs authorities, both in reference to matters affecting them individually and on the broader issues which were involving the whole trade in never-ending trouble, but although discussions were pursued over a lengthy course nothing really concrete emerged. That the present situation is satisfactory would not be claimed by either party to the dispute and each must regret the time spent in exploring the pros and cons of a difficult situation. As a matter of fact the wording of the act needs amendment to "for use only in the recovery of metal" and the importers must be prepared to provide proof that the parcel in question has gone to a foundry for melting.

It may be objected that this procedure leaves loopholes for dishonest practice but what method does not suffer from the same defect? Easy enough surely to put the onus of obtaining the necessary certificate on the importer and at the same time to make it perfectly clear that uttering a false statement is a punishable offence. There are doubtless dubious characters in the scrap metal trade, and devious paths by which they earn their living, but there is not much wrong with the houses occupied in bringing scrap into this country from abroad. These traders have plenty of trouble already without looking for more by trying on fancy tricks with the Customs.

Outlook for Copper

By "ONLOOKER."

During the first half of this year the copper market has lived through some very exciting times and sentiment has alternated between super optimism and black despair! First came the period preceding the agreement upon curtailment when opinion was sceptical of any successful outcome to the negotiations and values sagged accordingly; following which we had the spectacular rise of about £7 during which consumers bought freely, at any rate in the early stages, and speculators with the bit between their teeth took the movement much further than was safe. Somewhere around the top some American interests hedged their holding by selling on the standard market and their astuteness was rewarded, for when the N.R.A. collapsed values in London fell in break-neck fashion. Since then there was a brief rally on the strength of a meeting of the producers' marketing committee in London but some reaction occurred and the highest point reached was not maintained.

"Peace after storm" is a phrase which might not inaptly be applied to the copper situation as it now is, for during these holiday weeks the market appears to have settled down to a steady jog trot with minor day-to-day fluctuations which do not make anybody much up or down on balance. In the States, following on very heavy buying in the early part of July, producers are satisfied to hold their hands, and bids from London at a few shillings under the official Metal Exchange price for electro have been refused. In this country consumers are showing very little interest and even before the holiday season began there was not much business being done. By the great majority this is regarded as a certain sign that in the autumn a big buying movement will develop as a result of which prices will go ahead and settle down at a level higher than we have yet seen this year. Consumption in Britain is held still to be on the up-grade and much faith is pinned to the unpleasant prospect of heavy buying in connection with the manufacture of munitions on the continent. In the United States too, it is claimed that the outlook is much brighter and all these factors set off against the existence of a curtailment pact make it almost certain that a higher level will be reached and maintained.

International Uneasiness

Yet there is no evidence of any speculative rush to buy copper, and, as stated above, manufacturers are sticking strictly to a hand-to-mouth policy, which indicates clearly enough that they do not regard the situation very favourably. These holding-back tactics do not necessarily suggest lack of faith in the copper situation *per se*, but rather anxiety over international affairs both as regards the maintenance of peace and the monetary crisis in various European countries. Nowadays the sequence of events is quite incalculable, and what appears to be obvious does not by any means always materialise, for the times are out of joint and things have a way of turning out quite contrary to expectations. It is certainly difficult to see what can upset the prospect of an upward trend for copper later in the year, unless, of course, the curtailment pact should develop "leaks." This would, of course, be a disaster of the first magnitude, but it can hardly be ruled out as a possibility, especially if copper climbs up into the forties, at which level there are plenty of producers who would be netting very handsome profits even on a reduced output. In conclusion, it may be said that, although the stage seems to be set for a rise in values, there is an underlying feeling of uneasiness.

XUM

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W21

This Week's News in Brief

Trade Talk

AN IMPORTANT CONTRACT has been placed with Messrs. Lobnitz & Company, Limited, Renfrew, for a suction dredger for service in India.

ROBEY & COMPANY, LIMITED, Globe Works, Lincoln, announce that, their reorganisation now being effective, they have resumed trading under the former management.

THE NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED, Glasgow, have had a roof garden made above the rear entrance to their works in Adamswell Street, Springburn. The garden is one of the features of the district.

TO MEET THE shortage of pig-iron in Japan a number of smelting furnaces are being built, including a 1,000-metric-ton furnace at the Yawata-Seitetsuho of the Nippon Seitetsu, a 350-metric-ton furnace at the Japan Steel Pipe Works, and a 170-metric-ton furnace at the steelworks at Asano.

AS A MEMORIAL to the late Sir Ashton Lister, their founder and first chairman, Messrs. R. A. Lister & Company, Limited, have presented Kingshill House and the grounds surrounding it to the Dursley Rural District Council. The house is to be used as Council offices, and the grounds as a children's playground.

AN INTERESTING CEREMONY in connection with the introduction of new enamelling plant at the Chattan Foundry of Messrs. Mitchell Russell & Company, Limited, Bonnybridge, took place recently, when the new department was formally opened by Mrs. George Albert Ure, of Wheatlands, Bonnybridge.

TWO ADMIRALTY reserve oil tankers, H.M.S.S. "Trefoil" and "Turmoil," both of 1,700 tons, have arrived at the Bridgeness shipbreaking yard, Bo'ness, for demolition. The demolition will provide welcome employment for Bo'ness shipbreakers, and this will be augmented shortly when two other Admiralty oil tankers are brought to the breaking-up yard.

A PARTY OF ENGINEERING APPRENTICES of the firm of Messrs. G. & J. Weir, Limited, Cathcart, Glasgow, visited Germany during the Glasgow Fair holidays for the purpose of studying engineering and industrial conditions in that country. The visit was arranged by Messrs. Weir in conjunction with Messrs. Schiss-Defries, machine-tool manufacturers, Düsseldorf.

AT FALKIRK DEAN OF GUILD COURT, on August 1, Mr. Walter W. Mitchell, director of Grahamston Iron Company, Limited, Grahamston Iron Works, was granted permission to erect a warehouse at the works, at a cost of approximately £600. In granting warrant, Bailie Wallace said that it was gratifying to see the light-castings industry was flourishing, and they would be only too willing to grant warrants of that nature.

THE SHIPYARD OF Messrs. Harland & Wolff, Limited, at Greenock, has been purchased by National Shipbuilders Security, Limited. The yard has been closed for the last seven years, as Messrs. Harland & Wolff have concentrated activities in their Glasgow establishment. No ship has been produced in the yard since one was launched in 1928. The yard will now be kept by National Shipbuilders Security on a care-and-maintenance basis.

THREE OLD STEELWORKS, the pioneers of the trade in Scotland, are to go out of existence. Demolition work has been commenced at Pather Iron & Steel Works, Wishaw, and Calderbank Steel Works, Airdrie, while the Mossend Works have been in the hands of demolishers for some time. Pather, Calderbank and Mossend have been household words in Lanarkshire, and their produce has been used all over the world. At one time they gave employment to thousands of men. Calderbank was amalgamated with the Colville combine some years ago, and likewise Mossend.

SPEAKING AFTER THE LAUNCH of the motorship "Bingera," whose main machinery, consisting of a four-stroke cycle single-acting Diesel engine of the Burmeister & Wain type, constructed by Messrs. Kincaid & Company, Limited, Greenock, Mr. Maurice Denny, chairman of Messrs. William Denny & Bros., Limited, Dumbarton, said if the launch left an empty slip, it at least put something into the dock. There were still some slips filled—some well filled and others not quite so well. He said that during the period 1878-1913 his firm delivered a ship of some kind every fortnight, year in and year out —650 ships in 25 years. One-half of that rate of activity would now represent their idea of industrial Utopia, or, alternatively, if a moderate increase in demand could be coupled with a slightly more generous acknowledgement of their services, everything would once again be for the best.

A NEW COMPANY, to be known as the Scotia Iron & Chemical Company, Limited, has been formed to take over the idle ironworks and cement plant at Langloan, Coatbridge. The works have been idle since 1920. They comprise five blast furnaces of the traditional Scottish type, together with a by-product-recovery plant. Recently a modern rotary cement-making plant was erected at a cost of about £150,000, but has never been in operation, whilst other improvements cost a further £100,000. It is estimated that the stock of slag is sufficient to supply the cement-making plant for ten years. Blast-furnace slag is already made in large quantities in Scotland by the Caledonian Portland Cement Company, Limited, and this company sells the cement production of the Glasgow Iron & Steel Company, Limited, Wishaw; the Coltness Iron Company, Limited, Newmains; and of William Baird & Company, Limited, Coatbridge.

AFTER TWO MONTHS without an order for a vessel being placed, the Clyde has secured orders for seven vessels, covering a wide variety of tonnage. Messrs. Lithgows, Limited, Port Glasgow, have secured two cargo liners, each of 7,500 tons, for Scindia Steamships (London), Limited, for which the propelling machinery, consisting of triple-expansion engines, will be supplied by Messrs. John G. Kincaid & Company, Limited, of Greenock. Messrs. Scott & Sons, Limited, Bowling, have secured five vessels, including a 250-ft. motor coaster for Australasian United Steam Navigation Company; a 500-ton motor vessel for Messrs. J. & A. Gardner & Company, Limited, Glasgow; a motor coaster for another British firm; a cargo steamer for South African owners; and a powerful tug for the Crown Agents for the Colonies for service at Haifa, Palestine. This tug will be fitted with triple-expansion engines developing 1,100 i.h.p.

Personal

MR. JAMES DUCKWORTH has been presented with an occasional table and mahogany timepiece, in recognition of his services to the Bury Branch of the National Union of Foundry Workers, of which he has been secretary for thirty years, until his recent retirement.

LORD RIVERDALE, chairman and managing director of Messrs. Arthur Balfour & Company, Limited, Capital Steelworks, Sheffield, has been appointed chairman of the Departmental Committee on Co-ordination of Fire Brigades in case of National Emergency.

MR. JAMES J. GILLESPIE, a former employee of the Singer Manufacturing Company, Limited, Clydebank, the Albion Motor Company, Limited, Scotstoun, and of Messrs. Barr & Stroud, Limited, Anniesland, Glasgow, has been appointed editor of the "Works Manager."

A PIONEER OF THE shipbreaking industry on the Firth of Forth, Mr. Joseph McVeigh, manager of the shipbreaking yards of Messrs. P. & W. McLellan at Bo'ness, has just retired after more than 30 years' service. Mr. McVeigh, a native of Ulster, began life at the Belfast yard of Messrs. Harland & Wolff, Limited, as a shipbuilder, and after a further period at Bowling he went to Bo'ness in 1905 to serve with the Forth Shipbreaking Company, Limited, which was merged into the present company in 1921.

THE EARL OF DUDLEY was elected Vice-President of the Birmingham Chamber of Commerce on Monday. This means that he will be President in two years' time. He has been a member of the Council for several years and also is on the Management Board of the British Industries Fair (Birmingham). Lord Dudley is President of the British Iron and Steel Federation. He is chairman of the Earl of Dudley's Baggeridge Colliery, Limited, and of the Earl of Dudley's Round Oak Works, Limited.

Obituary

MR. DAVID NUTTALL HARDMAN, who died recently at the age of 51, was partner with his brother in the firm of R. Hardman & Bros., ironfounders, of Bacup, Lancashire, a business founded by their father in 1858

MR. NORMAN OSBORNE FULTON, chairman of Albion Motors, Limited, and one of the pioneers of the motor-car industry in Scotland, died at his home in Milngavie, Dumbartonshire, on July 27. In association with the late Dr. T. Blackwood Murray, he founded, in 1899, the Albion Motor Car Company in Glasgow.

MR. JAMES WYPER, retired ironfounder, who died on August 2, built Comely Bank Foundry, in company with the late Mr. George Paul, the firm being known as Paul & Wyper. The partnership was later dissolved and the foundry sold to the late Mr. James Wright, of Denny, and with Mr. Wyper as manager it was carried on as the Comely Bank Foundry Company. Mr. Wyper retired in 1921.

MR. CHARLES EDMUND STROMEYER, for over 30 years chief engineer of the Manchester Steam Users' Association, has died, at the age of 79. Mr. Stromeyer in his early years worked in marine-engineering works on the Tyne, and as a seagoing engineer, becoming in 1880 engineer surveyor to "Lloyd's Register." He was a past-member of the Council of the National Physical Laboratory and of the Institute of Naval Architects, a Past-President of the Manchester Association of Engineers, a member of the General Committee of the British Association, and a member of the following institutions:—Civil Engineers, Mechanical Engineers, Iron and Steel Institute, Manchester Association of Engineers, and the British Astronomical Association. He had contributed a large number of Papers to those institutions, and also to the Royal Society and to international congresses. The Council of the Institution of Civil Engineers awarded him the Telford Medal and two Telford Premiums.

Contracts Open

Johannesburg, August 17.—500 35-ft. wrought-steel lighting poles, for the City Council of Johannesburg. The Department of Overseas Trade. (Reference T.Y. 5,110.)

Dursley, August 14.—One and a-quarter miles of 3-in. spun cast-iron mains, for the Council. Messrs. A. P. I. Cotterell & Son, 54, Victoria Street, London, S.W.1. (Fee £2 2s., returnable.)

Langport, August 14.—Seven miles of 4-in. dia. and 11 miles of 3-in. dia. cast-iron water mains and fittings, for the Rural District Council. Major W. H. Bateman, engineer, Batheaston, Bath. (Fee £5 5s., returnable.)

Riddlesden, August 13.—130 yds. of 12-in. dia. steel tubes with manholes, storm-water overflow, etc., and steel box lattice girder pipe bridge of 100 ft. clear span, for the Keighley Rural District Council. Mr. A. Brooksbank, engineer, 14, The Exchange, Bradford, Yorkshire.

Valley, August 14.—420 yds. of 3-in. spun-iron pipes in 12 ft. lengths; 960 yds. of 4-in. and 165 yds. of 3-in. spun-iron pipes in 12-ft. lengths, and 180 yds. of 2-in. cast-iron pipes in 6-ft. lengths, for the Valley Rural District Council. Messrs. H. Adams & Son, 60, Queen Victoria Street, London, E.C.4. (Fee £1, returnable.)

New Companies

(From the Register compiled by Jordan & Sons Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

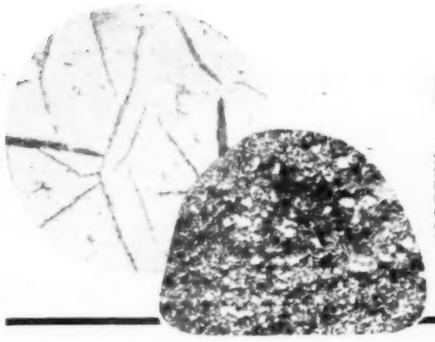
Steelworks, Limited, Dublin.—Capital £5,000. Directors: W. R. McGlennon, Torquay Road, Foxrock, County Dublin, and C. Heywood, 109, Ferguson Road, Dublin.

Shropshire Iron Company, Limited.—Capital £60,000 in 30,000 5½ per cent. non-cumulative preference shares of £1 each, and 120,000 ordinary shares of 5s. each. To acquire the undertaking and all or part of the assets of the Shropshire Iron Company, Limited. Directors: S. Cole, P. Fletcher and J. K. Henderson. Solicitors: Lawrence Jones & Company, Lloyds Building, London, E.C.

12 GRADES OF FREE-RUNNING FOUNDRY IRON

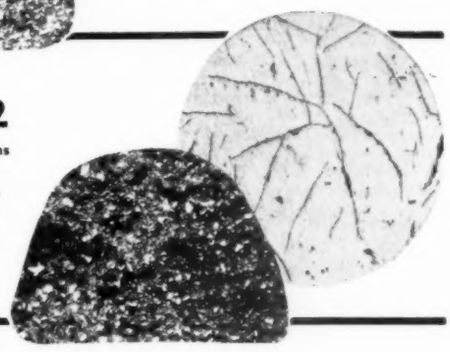
From the 33 grades of pig-iron produced in the Stanton Company's modern blast-furnaces, the foundryman can select an ideal iron for any type of casting. The various grades are grouped into three brands—Stanton, Holwell and "W'bro'" (Rixon's). All these irons will carry a good percentage of scrap, and produce sharply-moulded castings with smooth, clean surfaces free from blow-holes. They are available in notched pigs already broken in halves—a feature which facilitates handling and reduces labour costs.

Stanton and Holwell Foundry Irons are very similar in analysis. These free-running irons are particularly suitable for castings such as radiators, electrical goods, gas cookers, rainwater pipe, and all types of casting which are to be vitreous enamelled.



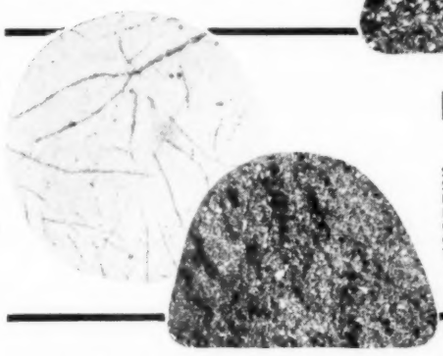
FOUNDRY No. 1

	Stanton %	Holwell %	Rixons %
Silicon	3.5	3.4	3.39
Sulphur	0.015	0.01	0.010
Phosphorus	1.36	1.4	1.62
Manganese	0.45	0.44	0.37
Graphitic Carbon	3.5	3.52	3.61
Combined Carbon	0.15	0.1	0.05
Total Carbon	3.65	3.62	3.66



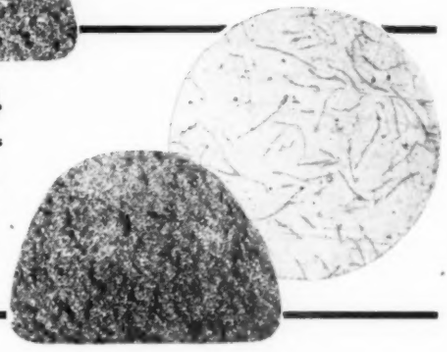
FOUNDRY No. 2

	Stanton %	Holwell %	Rixons %
Silicon	3.2	3.2	3.35
Sulphur	0.015	0.015	0.010
Phosphorus	1.36	1.39	1.68
Manganese	0.45	0.44	0.33
Graphitic Carbon	3.49	3.3	3.47
Combined Carbon	0.2	0.16	0.07
Total Carbon	3.69	3.46	3.54



FOUNDRY No. 3

	Stanton %	Holwell %	Rixons %
Silicon	2.91	3.0	3.29
Sulphur	0.025	0.02	0.025
Phosphorus	1.35	1.38	1.65
Manganese	0.46	0.44	0.34
Graphitic Carbon	3.35	3.16	3.52
Combined Carbon	0.3	0.3	0.12
Total Carbon	3.65	3.46	3.64



FOUNDRY No. 4

	Stanton %	Holwell %	Rixons %
Silicon	2.45	2.65	3.25
Sulphur	0.05	0.47	0.045
Phosphorus	1.35	1.36	1.65
Manganese	0.44	0.38	0.32
Graphitic Carbon	3.15	2.88	3.19
Combined Carbon	0.4	0.46	0.12
Total Carbon	3.55	3.34	3.31

STANTON LOW-PHOSPHORUS FOUNDRY PIG IRON

is particularly suitable for the heavier types of general engineering casting. Of similar analysis to Scotch iron, it produces high-strength castings which can easily be machined.

This iron can be supplied within limits of small margins of Silicon, the average analysis being: Silicon 2.0-4.0; Manganese 0.9-1.0; Sulphur 0.03; Phosphorus 0.73-0.78; Total Carbon 3.7.

STANTON PIG IRONS

The largest producers of Pig Iron (for Sale) in Great Britain

THE STANTON IRONWORKS COMPANY LIMITED, Near NOTTINGHAM

Raw Material Markets

The results of the discussions with the Continental Steel Cartel are now known and a feeling of general satisfaction prevails. Production is well maintained and the works are well occupied in spite of the holiday interruptions. Two announcements of extensions of plant have been made, by Messrs. Dorman, Long & Company and by the South Durham Steel & Iron Company. These extensions will be for the cold-rolling of sheet and strip. Although there have been meetings by the ironmasters, no further alteration in pig-iron prices has been announced.

Pig-Iron

MIDDLESBROUGH.—Many consumers in this area have purchased pig-iron well ahead in anticipation of an increase in price. It seems unlikely, however, that an advance will be made for a considerable time. Deliveries to Scotland have now been resumed in full and conditions on the whole are exceptionally favourable for this time of the year. Prices are unchanged, the fixed quotations for No. 3 Cleveland G.M.B. being 67s. 6d. per ton delivered in the Middlesbrough area, 69s. 6d. on the North-East Coast, 67s. 3d. in Falkirk and 70s. 3d. in Glasgow.

The increase in the price of hematite seems to have had the effect of reducing sales, for very little has been sold recently, most consumers having bought before the change in price occurred. Should Italy fulfil her promise to liquidate her debts, exports of hematite to that country are likely to increase considerably. Quotations for No. 1 East Coast quality are 71s. per ton delivered Middlesbrough, 72s. delivered Tyneside, 73s. 6d. delivered Durham and Northumberland, 77s. 6d. delivered Scotland and 78s. 6d. delivered Sheffield.

LANCASHIRE.—Less active conditions have prevailed on the foundry-iron market this week. Holiday interruptions have caused suspensions of deliveries and as a result the total tonnage has decreased. Local consumers are buying in larger quantities, but contract buying has been reduced. On the whole, conditions remain satisfactory and an increase in consumption is anticipated directly the holiday period closes. Staffordshire, Derbyshire and Lancashire brands of No. 3 iron equal to Derbyshire are all on the basis of 74s. per ton, with Northamptonshire foundry iron at 72s. 6d., and Scottish No. 3 at around 82s.

MIDLANDS.—Prices on this market are unchanged at the old levels of 67s. 6d. for Northants No. 3 and 71s. for Derbyshire, Lincolnshire and South Staffs No. 3, including delivery to Birmingham and Black Country stations. Very little new business has been transacted, ironfounders being well covered for six or nine months. The price of special refined pig-iron is between £5 7s. 6d. and £7 per ton, low-phosphorus, including Scottish, is at from 85s. to 90s., and medium-phosphorus from 72s. to 80s., delivered Midland stations. A fair amount of hematite iron is going into consumption, in this district at the recently revised prices, but no indication of any shortage is reported.

SCOTLAND.—New business is scarce, but prices have been held firmly at the official minimum of 70s. for No. 3 foundry f.o.t. furnaces, with 2s. 6d. extra for No. 1. Large founders have been buying ahead, but small founders are only buying from day to day, according to their immediate requirements. The light-castings trade is taking moderate quantities of Cleveland iron and most founders are contracted till the end of the year. No change in the official prices of Cleveland iron has been reported—they are, 67s. 3d. f.o.t. Falkirk and 70s. 3d. f.o.t. Glasgow. Other English irons are 1s. 3d. per ton less. The steelworks have restarted with well-filled order-books in spite of the lack of shipbuilding contracts. Prices of hematite and basic iron are:—Mixed numbers, Scottish hematite, 71s.; ordinary mixed numbers West Coast hematite, 75s.; ordinary mixed numbers East Coast hematite, 77s. 6d.; basic, British and Indian, 70s. (less 5s. rebate), all delivered steelworks.

Coke

Little change is noted in the foundry-coke market. Orders are mainly for small parcels for immediate delivery. Durham foundry coke is quoted at 20s. to 21s. at ovens. For delivery in Birmingham and district quotations for Welsh coke range from 31s. to 42s. 6d. per ton and best Durham from 35s. to 40s., with other grades down to 33s. to 34s.

Steel

Holiday influences have resulted in a slackening of business in the steel markets, but the position remains sound and there is no lack of confidence in the future. Users of semi-finished steel are covered ahead, and consequently are not buying much fresh material at the moment, but the works have good orders in hand and will be busy for some time. Finished steel maintains a strong tone in all departments, and, except in sheets, orders are on a good scale.

Scrap

Importations from the United States to the Cleveland district have been in considerable quantities recently and the news of a further advance of 50 cents per ton in the price of American steel scrap has thus been of great interest. The increase is likely to stop imports completely. Heavy melting steel is easily disposed of at 52s. 6d. per ton and ordinary cast iron is also at 52s. 6d. Machinery metal is 55s. per ton and light metal 43s. 6d. to 44s. per ton delivered works. Heavy steel turnings are still at 35s., and cast-iron borings at 25s. per ton. The South Wales steelworks are heavily stocked and the volume of business being done is not great. Heavy mild-steel scrap in furnace sizes is featureless at 55s. to 56s. and bundled steel scrap is dull at 52s. to 54s. Good, clean, heavy, mild-steel turnings are only selling in small parcels at 45s. to 46s. Heavy cast iron in large pieces and furnace sizes is at 50s. to 52s. and is still in poor demand. Light cast-iron scrap has a steady following at 42s. 6d. to 44s. Quiet conditions prevail on the Midland market, where heavy machinery metal in handy sizes is quoted at 55s. to 57s. 6d., good heavy at 50s. and clean light cast-iron scrap is at 47s. 6d. delivered works. In Scotland foundries are getting their full requirements of scrap and are not prepared to raise prices above those ruling prior to the holidays.

Metals

Copper.—The demand for copper for trade purposes has been very quiet and only a small volume of business has resulted. Seasonal influences account for the lack of demand. However, the undertone of the market has improved and the outlook is still regarded as promising. The American market has been fairly quiet, but quite large tonnages have been purchased for export to Japan.

Daily market prices:—

Cash.—Thursday, £31 17s. 6d. to £31 18s. 9d.; Friday, £32 1s. 3d. to £32 2s. 6d.; Tuesday, £32 3s. 9d. to £32 5s.; Wednesday, £32 6s. 3d. to £32 7s. 6d.

Three Months.—Thursday, £32 5s. to £32 6s. 3d.; Friday, £32 8s. 9d. to £32 10s.; Monday, £32 8s. 9d. to £32 10s.; Tuesday, £32 11s. 3d. to £32 12s. 6d.; Wednesday, £32 13s. 9d. to £32 15s.

Tin.—The tin market has been steady, but rather quiet. A meeting of the International Tin Committee has been arranged for August 9 and considerable interest is centred around the result of this. It is expected that the question of the extent to which quotas of production will be raised will be discussed. An increase of production may be taken for granted, but it is not known by how much.

Day-to-day fluctuations:—

Cash.—Thursday, £233 15s. to £234; Friday, £233 10s. to £234; Tuesday, £233 17s. 6d. to £234; Wednesday, £233 15s. to £234.

Three Months.—Thursday, £219 5s. to £219 10s.; Friday, £219 15s. to £220; Tuesday, £215 15s. to £216; Wednesday, £216 15s. to £217.

Spelter.—This metal has been rather irregular of late, and has not responded to the firmness of copper, as was expected. Little interest has been taken by buyers and consumption has only expanded a little. It is anticipated that once the holidays are over the consumption of spelter will improve considerably. India has taken up fair quantities of this metal, but otherwise there is nothing of note to report.

Official quotations were as follow:—

Ordinary.—Thursday, £14 6s. 3d.; Friday, £14s. 6s. 3d.; Tuesday, £14 1s. 3d.; Wednesday, £14 3s. 9d.

Lead.—The highest level of the year in prices has been reached recently and also the peak figure since 1930. The holidays have affected the demand, but Italy is reported to have purchased 1,000 tons last week. Russia has been a large purchaser of lead. The future appears to be favourable with, perhaps, a further rise in price.

Day-to-day quotations:—

Soft Foreign (Prompt).—Thursday, £15 12s. 6d.; Friday, £15 11s. 3d.; Tuesday, £15 8s. 9d.; Wednesday, £15 10s.

Company Reports

Herbert Morris, Limited.—Full half-year's dividend to July 31 on the 5 per cent. cumulative preference shares.

Davey Paxman & Company, Limited.—After depreciation, fees and interest on debenture stock, balance is £3,424, less £1,548 to reserve (making this £10,000); carried forward, £1,876.

Warner & Company, Limited.—Profit, £3,491; brought in, £1,174; transferred from reserve, £1,000; directors' fees, £400; income tax, £397; audit fee, £50; preference share dividend, £2,092; dividend on the ordinary shares of 2½ per cent., £775; depreciation, £1,000; carried forward, £951.

General Refractories, Limited.—A progress report for the half-year to June 30 last states that sales were 27½ per cent. up compared with the previous half-year. Profits for the period are estimated at not less than £27,000. For the whole of 1934 the gross profit was £42,672. An interim dividend of 6 per cent. is announced.

Lancashire Steel Corporation, Limited.—At a meeting, held recently, the board had under consideration the trading results for the six months to June 30, 1935, which they state are satisfactory. In view of the position, the board decided to declare an interim dividend on the issued 5½ per cent. non-cumulative redeemable second preference shares in respect of the year to December 31, 1935, at the rate of 2¾ per cent., less tax.

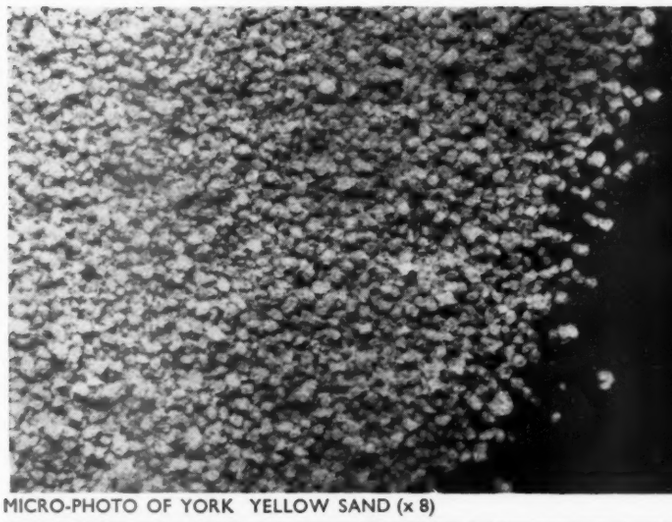
Thermal Spalling of Fire-Clay Brick

A discussion of the probable relation between linear thermal expansion, modulus of rupture, modulus of elasticity, and the resistance of fire-clay brick to thermal spalling is given in the "Bulletin of the American Refractories Institute." It points out, because of the readiness with which the linear thermal expansion of the usual type of fire-clay brick decreases, or in the case of the siliceous type of brick increases, when heated at a temperature higher than reached during the manufacturing process, and also because of the temperature gradient in bricks in furnace walls which are being heated or cooled, large stresses may be set up in the bricks. Unless the bricks in which such stresses are set up have the necessary extensibility to permit adjustment of the various sections of the brick to the stresses rupture will take place. The extensibility of the refractory brick or shape is decreased as a rule (*a*) by increasing the temperature of firing during manufacture, (*b*) by using comparatively fine grog sizes in their composition, and (*c*) by decreasing the amount of grog. Refractory shapes apparently show less resistance to thermal shock if they contain vitreous grog rather than porous. Furthermore, of two brands of bricks which have approximately the same properties at room temperature, that brand showing the greatest decrease in extensibility between room temperature and 600 deg. C. (1,112 deg. Fah.) will have the lower resistance to thermal shock.

THE DIRECTORS of the Great Western Railway Company announce that gross receipts from railway and ancillary businesses for the half-year ended June 30 were £35,000 more than in the corresponding period of last year Expenditure on railway and ancillary businesses increased by approximately £18,000, and the increase in net revenue from all sources, including interest, amounted to £25,000.

XUM

Moulders who want a sand with that little extra resistance for casting iron and iron alloys at high temperature, and which will produce a good skin on the casting, will find no better medium than York Yellow Sand. It is well bonded, fine in grain, yet permeable and highly refractory.



YORK YELLOW

MICRO-PHOTO OF YORK YELLOW SAND (x 8)

GENERAL REFRACTORIES LIMITED.

Telephones:	*Head Office:*	*Telegrams:*
Sheffield 22311 (5 lines).	Genefax House, Sheffield.	Genefax, Sheffield.
	London Office:	
London 7361 Temple Bar.	Russell House, Adelphi, W.C.2.	Genefax, Rand, London.
	Glasgow Office:	
Central 5250.	156, St. Vincent Street, C.2.	Genefax, Glasgow.

RAW MATERIALS—PRICE LIST

(Wednesday, August 7, 1935)

COPPER

	£	s.	d.
Standard cash	32	6	3
Three months	32	13	9
Electrolytic	35	10	0
Tough	33	15	0
Best selected	34	5	0
Sheets	62	0	0
India	45	10	0
Wire bars	35	15	0
Ingot bars	35	15	0
H.C. wire rods	39	10	0
Off. av. cash, July	31	1	4 3/16
Do., 3 mths., July	31	9	7 5/16
Do., Sttlmnt., July	31	1	7 1/16
Do., Electro, July	34	11	10 3/16
Do., B.S., July	33	16	11 1/16
Do., wire bars, July	34	18	5 1/16
Solid drawn tubes			10d.
Brazed tubes			10d.
Wire			6d.

BRASS

Solid drawn tubes	9¼d.
Brazed tubes	11½d.
Rods, drawn	8d.
Rods, extd. or rlld.	4¼d.
Sheets to 10 w.g.	7½d.
Wire	7¾d.
Rolled metal	7d.
Yellow metal rods	4¼d.
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d.

TIN

	£	s.	d.
Standard cash	233	15	0
Three months	216	15	0
English	234	0	0
Bars	236	0	0
Straits (nom.)	238	15	0
Australian (nom.)	234	5	0
Eastern	227	10	0
Banca (nom.)	235	17	6
Off. av. cash, July	232	12	7 3/16
Do., 3 mths., July	233	8	8 3/16
Do., Sttlmt., July	232	14	4 1/16

SPELTER

	£	s.	d.
Ordinary	14	3	9
Remelted	14	10	0
Hard	11	10	0
Electro 99.9	16	16	3
English	15	2	6
India	13	0	0
Zinc dust	19	0	0
Zinc ashes	3	5	0
Off. aver., July	14	2	6
Aver. spot, July	14	1	3 1/16

LEAD

	£	s.	d.
Soft foreign ppt.	15	10	0
Empire (nom.)	16	11	3
English	17	10	0
Off. average, July	14	9	7 10/16
Average spot, July	14	9	0 5/16

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	22	2	6
Do., V.M. ex-whse.	23	15	0
Rods	29	0	0

ANTIMONY

	£	s.	d.		£	s.	d.
English	74	0	0	to 75	0	0	
Chinese, ex-whse.				69	0	0	
Crude, c.i.f.				27	10	0	

QUICKSILVER

	£	s.	d.		£	s.	d.
Quicksilver	11	2	6	to 11	12	6	

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£8 17 6
45/50%	£12 15 0
75%	£17 17 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/6 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£15 15 0
Ferro-tungsten—	
80/85%	3/- lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
2/4% car.	£33 10 0
4/6% car.	£21 15 0
6/8% car.	£21 0 0
8/10% car.	£21 0 0
Ferro-chrome—	
Max. 2% car.	£34 0 0
Max. 1% car.	£36 5 0
Max. 0.70% car.	£37 5 0
70%, carbon-free	9½d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	5/6 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to 11 5 0
76/80% packed	£11 15 0 to 12 5 0
76/80% export (nom.)	£9 15 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 7/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel	2	15	0	to 2	16	0	
Bundled shrngs.	2	7	6	to 2	15	0	
Mixed iron and steel	2	10	0	to 2	12	0	
Heavy cast iron	2	10	0	to 2	12	0	
Good machinery	2	12	6	to 2	15	0	
Cleveland—							
Heavy steel				2	12	6	
Steel turnings				1	15	0	
Cast-iron borings				1	5	0	
Heavy cast iron				2	12	6	
Heavy machinery	2	14	0	to 2	15	0	
Midlands—							
Light cast-iron scrap				2	7	6	
Heavy wrought iron				2	17	6	
Steel turnings				1	14	0	
Scotland—							
Heavy steel				2	10	0	
Ordinary cast iron				2	11	0	
Engineers' turnings				2	0	0	
Cast-iron borings	1	17	6	to 1	18	3	
Wrot-iron piling				2	17	6	
Heavy machinery				2	16	0	

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	27	0	0
Brass	18	0	0
Lead (less usual draft)	13	0	0
Tea lead	9	10	0
Zinc	9	0	0
New aluminium cuttings	66	0	0
Braziery copper	23	0	0
Gunmetal	25	0	0
Hollow pewter	160	0	0
Shaped black pewter	120	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—

Foundry No. 1	70/-
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	71/-
Hematite M/Nos.	70/6

N.W. Coast—

Hem. M/Nos. d/d Glas.	75/-
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-

Midlands (d/d Birmingham dist.)—

Staffs No. 4 forge	67/-
,, No. 3 fdry.	71/-
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/-
,, fdry. No. 3	71/-
,, fdry. No. 1	74/-

Scotland—

Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/-
Hem. M/Nos. d/d	71/-

Sheffield (d/d district)—

Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
W.C. hematite	86/-

Lancashire (d/d eq. Man.)—

Derby fdry. No. 3	74/-
Staffs fdry. No. 3	74/-
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/-
Clyde, No. 3	82/-
Monkland, No. 3	82/-
Summerlee, No. 3	82/-
Eglinton, No. 3	82/-
Gartsherrie, No. 3	82/-
Shotts, No. 3	82/-

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	9	12	6	to 9	15	0	
Nut and bolt iron	7	10	0	to 8	0	0	
Hoops	10	10	0	and up.			
Marked bars (Staffs) f.o.t.				12	0	0	
Gas strip				10	10	0	and up.
Bolts and nuts, ¾ in. × 4 in.				14	2	6	and up.
Steel—							
Plates, ship, etc.	8	15	0	to 8	17	6	
Boiler plts.	9	5	0	to 9	7	6	
Chequer plts.				10	7	6	
Angles				8	7	6	
Tees				9	7	6	
Joists				8	15	0	
Rounds and squares, 3 in. to 5½ in.				9	7	6	
Rounds under 3 in. to ⅜ in. (Untested)				8	12	0	
Flats—8 in. wide and over				8	12	6	
,, under 8 in. and over 5 in.				8	17	6	
Rails, heavy	8	5	0	to 8	10	0	
Fishplates	12	5	0	to 12	10	0	
Hoops (Staffs)				9	7	0	
Black sheets, 24g. (4-t. lots)				11	0	0	
Galv. cor. shts. (,,)				13	0	0	
Galv. flat shts. (,,)				13	10	0	
Galv. fencing wire, 8g. plain				14	10	0	
Billets, soft	5	10	0	and up.			
Billets, hard	6	17	6	to 7	2	6	
Sheet bars	5	2	6	to 5	10	0	
Tin bars	5	5	0	to 5	7	6	

PHOSPHOR BRONZE

	Per lb. basis.
Strip	9¾d.
Sheet to 10 w.g.	11½d.
Wire	12d.
Rods	11d.
Tubes	13½d.
Castings	12d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.31
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Malleable, Valley	18.50
Grey forge, Valley	18.00
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.60
Plain wire	2.30
Barbed wire, galv.	3.00
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
,, furnace	19/- to 20/-
Durham foundry	20/- to 21/-
,, furnace	16/6 to 17/9
Scotland, foundry	28/-
,, furnace	25/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		18/2 and up.
,,	28×20	,,	36/4 and up.
,,	20×10	,,	26/-
,,	18¾×14	,,	18/9
C.W.	20×14	,,	15/6 to 16/-
,,	28×20	,,	33/- to 33/6
,,	20×10	,,	23/3 to 23/9
,,	18¾×14	,,	15/9 to 16/3

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.		£	s.	d.
Pig-iron	£6	0	0	to	£7	0	0
Bars-hammered, basis	£16	0	0	to	£16	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to	£16	0	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£30	0	0	to	£31	0	0
Faggot steel	£18	0	0	to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0	to	£12	0	0

All per English ton, f.o.b. Gothenburg
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

	£	s.	d.	
Aug. 1 ..	31	17	6	inc. 8/9
,, 2 ..	32	1	3	,, 3/9
,, 6 ..	32	3	9	,, 2/6
,, 7 ..	32	6	3	,, 2/6

Standard Tin (cash)

	£	s.	d.	
Aug. 1 ..	233	15	0	inc. 2/6
,, 2 ..	233	10	0	dec. 5/-
,, 6 ..	233	17	6	inc. 7/6
,, 7 ..	233	15	0	dec. 2/6

Spelter (ordinary)

	£	s.	d.	
Aug. 1 ..	14	6	3	inc. 2/6
,, 2 ..	14	6	3	No change
,, 6 ..	14	1	3	dec. 5/-
,, 7 ..	14	3	9	inc. 2/6

Zinc Sheets (English)

	£	s.	d.	
Aug. 1 ..	22	5	0	inc. 5/-
,, 2 ..	22	5	0	No change
,, 6 ..	22	2	6	dec. 2/6
,, 7 ..	22	2	6	No change

Electrolytic Copper

	£	s.	d.	
Aug. 1 ..	35	0	0	inc. 5/-
,, 2 ..	35	5	0	,, 5/-
,, 6 ..	35	10	0	,, 5/-
,, 7 ..	35	10	0	No change

Tin (English ingots)

	£	s.	d.	
Aug. 1 ..	234	0	0	inc. 10/-
,, 2 ..	233	15	0	dec. 5/-
,, 6 ..	234	0	0	inc. 5/-
,, 7 ..	234	0	0	No change

Spelter (Electro, 99.9 per cent.)

	£	s.	d.	
Aug. 1 ..	16	18	9	inc. 5/-
,, 2 ..	16	18	9	No change
,, 6 ..	16	13	9	dec. 5/-
,, 7 ..	16	16	3	inc. 2/6

Lead (English)

	£	s.	d.	
Aug. 1 ..	17	10	0	inc. 5/-
,, 2 ..	17	10	0	No change
,, 6 ..	17	10	0	,, ,,
,, 7 ..	17	10	0	,, ,,

AVERAGE MONTHLY PRICES OF FURNACE COKE D/D MIDDLESBROUGH

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1903	0 15 9	0 16 0	0 16 3	0 16 9	0 16 6	0 16 3	0 16 0	0 15 9	0 15 6	0 15 0	0 14 6	0 14 0	0 15 8½
1904	0 13 9	0 13 9	0 13 3	0 14 3	0 14 6	0 14 3	0 14 3	0 14 3	0 14 3	0 14 0	0 14 0	0 14 6	0 14 1½
1905	0 14 9	0 15 3	0 15 3	0 15 3	0 15 6	0 15 6	0 15 6	0 15 6	0 15 6	0 15 6	0 15 9	0 17 0	0 15 5½
1906	0 17 6	0 17 6	0 17 0	0 17 0	0 17 0	0 16 6	0 17 0	0 17 0	0 18 3	0 18 6	0 19 0	1 0 0	0 17 8½
1907	1 4 6	1 5 0	1 5 0	1 0 6	1 2 0	1 1 0	1 1 0	1 1 0	1 2 0	1 1 6	1 0 0	0 17 0	1 1 8½
1908	0 16 0	0 16 0	0 15 6	0 16 0	0 16 3	0 16 0	0 15 6	0 15 6	0 15 6	0 15 3	0 16 0	0 15 9	0 15 9½
1909	0 16 0	0 15 3	0 15 0	0 14 9	0 15 6	0 15 9	0 15 6	0 15 6	0 16 6	0 17 0	0 17 6	0 17 0	0 15 11½
1910	0 18 4½	0 18 6½	0 18 0	0 18 0	0 17 10½	0 17 0	0 16 1½	0 15 9½	0 15 11	0 16 0	0 15 9½	0 15 8	0 16 11
1911	0 16 0	0 15 10½	0 15 6	0 15 3	0 14 9	0 14 6	0 14 6	0 14 6	0 14 6	0 14 11½	0 15 0½	0 16 3½	0 15 1½
1912	0 17 3	0 17 3	0 18 6	0 18 10	0 19 0	0 19 4½	0 19 10½	1 0 9½	1 2 9	1 4 1½	1 5 8½	1 8 6	1 1 0
1913	1 5 9	1 4 11	1 5 0	1 5 0	1 4 9½	1 0 4½	0 19 5½	0 18 3	0 18 0	0 18 2½	0 18 6	0 18 6	1 1 4½
1914	0 18 2	0 17 1	0 17 0	0 17 0	0 17 4	0 17 6	0 17 6	0 18 5	0 18 4	0 17 9	0 17 6	0 18 5	0 17 8
1915	0 17 10½	0 17 9	1 0 4½	1 7 7½	1 9 4½	1 10 7½	1 9 7	1 7 3	1 5 4	1 4 9	1 9 6	1 13 0	1 6 1
1916	1 10 9	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6½
1917	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 14 3	1 15 6	1 11 2½
1918	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6
1919	1 15 6	1 15 6	1 15 6	1 15 6	2 1 6	2 3 9	2 10 6	2 10 6	2 10 6	2 10 6	2 10 6	2 10 6	2 3 5
1920	2 12 3	2 14 0	2 19 0	2 19 0	3 3 8	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 2 6
1921	3 1 0½	2 19 0	2 16 0	2 7 0	2 6 6	2 6 6	2 0 6	2 0 0	1 13 11	1 12 9	1 10 4½	1 8 3	2 3 6½
1922	1 7 0½	1 8 1½	1 9 7½	1 8 4½	1 7 11½	1 7 3	1 6 9½	1 6 10½	1 7 0½	1 10 2½	1 10 0	1 9 11½	1 8 3½
1923	1 11 3	1 14 6	2 0 1½	2 2 8½	2 4 4½	2 2 10½	2 1 0½	2 1 6	2 0 9½	1 18 9	1 18 8½	1 18 3	1 19 7½
1924	1 16 6½	1 14 9	1 11 11½	1 10 0½	1 8 1½	1 7 8½	1 7 3	1 6 3	1 6 0	1 5 0	1 5 0	1 5 0	1 9 5½
1925	1 4 10½	1 4 1½	1 13 3	1 2 4½	1 2 2½	1 1 5½	1 1 3½	1 4 9	0 18 10½	0 18 4½	0 19 6½	1 1 4½	1 2 8½
1926	1 2 1½	1 0 9	0 19 2½	0 18 6½	*	*	*	*	*	*	*	1 5 0	1 1 1½‖
1927	1 5 6	1 4 9½	1 6 1½	1 3 9	1 2 6	1 0 8½	0 19 4½	0 19 0	0 18 7½	0 18 0	0 17 10½	0 17 6	1 1 1½
1928	0 17 6	0 17 10½	0 18 0½	0 17 11½	0 17 8½	0 17 6½	0 17 7½	0 17 6½	0 17 6	0 17 7½	0 17 7½	0 17 6	0 17 8
1929	0 17 7½	0 18 0	0 19 0	0 19 6½	0 18 10½	0 19 10½	1 1 3½	1 1 8½	1 3 0	1 3 6	1 3 8	1 3 1½	1 0 9½
1930	1 2 6½	1 1 3	1 0 3	0 19 1½	0 17 7	0 16 10½	0 16 6	0 16 6	0 16 9	0 17 0	0 17 0	0 17 0	0 18 2½
1931	0 17 0	0 16 7½	0 16 0	0 16 0	0 15 11	0 15 5	0 15 1	0 15 0	0 15 0	0 16 9	0 17 0	0 16 6	0 16 0½
1932	0 17 0	0 16 11½	0 16 5½	0 15 9	0 15 7½	0 15 6	0 15 6	0 14 9½	0 14 6½	0 14 6	0 14 6	0 15 4	0 15 6½
1933	0 16 0½	0 15 11½	0 15 6½	0 15 6	0 15 6	0 15 6	0 15 6	0 15 8½	0 16 1½	0 17 0	0 17 6	0 18 9	0 16 1½
1934	0 19 1½	1 0 6	1 0 2	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	0 19 11½
1935	1 0 0	0 19 6½	0 19 0½	0 19 0	0 19 0	0 19 0	0 19 0	—	—	—	—	—	—

* Strike period. ‖ Five months.

TN ORANGE

WINCHESTER HOUSE, OLD BROAD STREET, LONDON, E.C.2.
Telegrams:- "ALKALIZE, STOCK, LONDON" Phones:- LONDON WALL 7955 (5 LINES)

AC GARNET

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FINE WHITE

Notice

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-
(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

FOUNDRY FOREMAN required for large works in Bristol district. Write stating age, experience and wages required, to Box 332, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY MANAGER wanted having experience in the machine production of repetition castings. Applicants please give full details, stating age and salary required, to Box 338, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

A PROMINENT firm of Gas-Appliance Manufacturers in the Midlands require the services of a Patternmaker with first-class experience, preferably in the light-casting trade. Applicants must be under 35 years of age, and be prepared, if required, to take up an appointment in a Colonial depôt. Reply in confidence, giving full details of past experience and salary required, to Box 334, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

THE South African Iron & Steel Industrial Corporation, Ltd., Pretoria, require the services of an experienced Foundry Foreman. He must have good knowledge and sound experience in the casting of ingot moulds, also cast-steel rolls, cast-iron rolls and chilled rolls used in the manufacture of all classes of heavy and light mill products, as well as foundry experience in brass and other non-ferrous alloys. Reply, stating age, salary, full experience, etc., to SOUTH AFRICAN IRON & STEEL INDUSTRIAL CORPORATION, LTD., c/o The International Construction Co., Ltd., 56, Kingsway, London, W.C.2.

WANTED. Foreman with experience of the machine moulding of small castings. Knowledge of floor moulding an advantage. Apply, giving full details, stating age and salary required, to Box 336, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

MOULDER, age 33, in small foundry, desires similar position in large foundry centre, Midlands or London areas preferred. Competent workman, technical knowledge. (264)

YOUNG MOULDER requires position as Moulder or in charge. Excellent experience iron (repetition work), brass, aluminium and special alloys. Technical training. (265)

FOREMAN requires similar position or as Assistant Foreman. Engineering, machine-tool and millwright castings, cupola practice, high-duty cast iron; accustomed to systems of payment by result. (266)

MACHINERY

WANTED. Must be in good working order. One Ronceray Mill, BMC240, approx. 7 ft. dia., capacity 15 tons.—Box 340, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOR SALE. Jackman No. 4 Cupola, rated capacity 6/7 tons, in good condition: £75. Apply E. HIND, Imperial Works, South Bank-on-Tees.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

SANDBLAST PLANTS

Room Plants, sizes 12 ft. x 12 ft., 12 ft. x 9 ft. and 6 ft. x 6 ft., made up in cast-iron sections.

Barrel Plants, 30 in. dia. x 36 in. long and 30 in. dia. x 18 in. long rotary barrels.

Cabinet Plants, in sizes 4 ft. x 4 ft. x 4 ft., 36-in. dia. and 30-in. dia. operators' cabinets.

Most of the above by Tilghman and complete with Air Compressors.

HAND MOULDING MACHINES

By Adaptable, Pridmore, Darling & Sellars, etc.; Squeezers by Utard (unused), Samuelson and Britannia, also Farwell Universal Type.

Ladles, Grinding Machines, Exhaust Fans, Blowers, Air Compressors and 500 Electric Motors and Dynamos.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.

CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.
'Phone: Broadwell 1359.

THOS. W. WARD LTD.

Motor-driven 7" VENTILATING FANS (Verity-Davidson); 220-v. d.c. motor; 0.3 b.h.p. with switch, etc.

40" D.E. DISC GRINDER (Roberts Bros.); two T slotted table, 2' 6" x 1' 8"; adjust horiz., and fitted with quick trav.

Babcock W.T. BOILER, of 4,356 sq. ft. heating surface; 150 lbs. w.p.

Two 35-n.h.p. semi-port. LOCO. BOILERS; 140 lbs. w.p.

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